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ABSTRACT

This resource guide has been prepared to help high school personnel infuse energy education into the basic education program of grades 10-12. The resource guide has two major sections. The first deals with the "why, what, when and where" questions of energy education including a set of objectives and concepts relative to energy education at the high school level. The second section addresses the "how" question and includes annotated listings of curriculum guides, periodicals, organizations interested in energy education, audio visual materials, computer software, and Massachusetts energy statistics. (CW)

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A MESSAGE FROM SECRETARY SHARON M. POLLARD

Dear School Administrator and Educator:

The Executive Office of Energy Resources oversees the energy policies and the majority of energy programs in the Commonwealth. In this role, EOER supports the development of comprehensive energy policy which simultaneously increases our energy security and preserves our environment. All of our initiatives are directed toward achieving improved energy efficiency and the development of renewable energy resources.

Clearly one way to achieve our aims is to provide appropriate and adequate energy information to school age children in the Commonwealth. In this was we can help ensure that the future heads-of-household and energy consumers make informed decisions related to their environment and energy consumption. EOER has, through its Energy Education Program which is operated by the Massachusetts Audubon Society, assumed an active role in advocating for the development of energy programs in Massachusetts schools.

A first and very important step was the development and dissemination of the first edition of the ENERGIZERS energy education curriculum resource guide for upper secondary teachers. The resource guide represented a compilation of energy education curriculum and materials utilized by educators throughout the United States. This very valuable educational information was, for the first time, easily available to Massachusetts educators. EOER and the Massachusetts Audubon Society, recognizing the need for updated and expanded information, have collaborated to produce this second edition of the ENERGIZERS energy education curriculum resource guide.

EOER and the Massachusetts Audubon Society invites you to join us in our goal to infuse energy education curriculum into our schools, and, in so doing, help create a sound energy future in the Commonwealth.

Sincerely,

Sharon M. Pollard
Secretary of Energy Resources

SMP/CAT/lh

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INTRODUCTION

Teaching youngsters the basic facts about energy and its impact on our lives is one of those fundamental things we all know should be done but which is apt to get sidelined in the press of daily life. When the media and the government proclaim that there is an energy crisis there is a scurry of activity, a rush to generate some curriculum materials, then a dwindling of effort when the "crisis" seems to be somewhat abated. However, energy management is eternally ongoing, and how we manage it affects how we can live our lives individually and collectively. Energy is basic to our daily lives, and the study of it must find a basic place throughout our schools' curricula.

This resource guide has been prepared to help school personnel infuse energy education into the basic educational program of the upper secondary grades — ten through twelve. It assumes a broad diversity of educational approaches and the importance of the teacher in making instructional choices. It should be particularly useful to schools where administration and instructional staff are jointly planning to implement energy education over several years.

This guide is a companion to *Energizers, a guide to the best in energy education materials for the middle grades*, (grades 6-8). This guide focuses on resources useful to teachers in upper secondary schools — grades ten through twelve. However, many materials listed in this volume and in the earlier version do not fit neatly into the targeted grade levels. Because of this overlap, materials that are applicable for grades 9 and lower, are only included in the middle grades version. Materials designed for students in grades seven through twelve are included in both resource guides. Teachers of students in grade nine will undoubtedly find materials in both volumes of use to them in their teaching.

The resource guide has two major sections. The first deals with the **Why, What, When, and Where** questions of energy education including a set of objectives and concepts relative to energy education in the high school. These are not presented as the final word but as take off points for a school staff to tailor its own objectives and concepts for their curricula. The second section addresses the **How** question and includes annotated listings of curriculum guides, periodicals, organizations interested in energy education, potential field trip destinations, and audio-visual aids.

The three ring binder format will allow updating of materials and the addition of resources you discover from other sources and would like to keep in a central location. We are always eager to hear from users on ways this guide might be made more useful in future editions. Send your comments to:

Education and Public Policy Department
Massachusetts Audubon Society
Lincoln, MA 01773
(617) 259-9500 ext. 7255

A NOTE FOR NINTH GRADE TEACHERS

This guide reviews materials designed for use in grades 10-12. However, secondary students vary greatly in their abilities and as a result secondary teachers also might find useful some materials intended for grades 7-9.

Energizers — a Guide to the Best in Energy Education Materials for the Middle Grades reviews many materials suitable for grades 7-9. Some of the materials that may be useful in grades 9 and 10 are listed below. For full review, please consult *Energizers* for the middle grades. Copies may be obtained from the electric utility company serving your school.

Name	Producer	Page in Energizers
Electric Gnus	Innovative Communications	23
Energy 80	Enterprises for Education	39
Energy Crunch	Energy Source Education Program	35
Energy In American History	Energy Source Education Program	35

ACKNOWLEDGEMENTS

Compilation of a resource guide such as this is of necessity a group effort that requires input from a number of people. Fortunately, this work builds in many ways upon the contributions of the many people who helped make possible the preceding publication, *Energizers — a Guide to the Best in Energy Education Materials for the Middle Grades*. I am grateful for all the people involved in its production and too numerous to repeat here.

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To all these I extend my thanks.

Thomas Wellnitz, Coordinator
Energy Education Program and
Resource Guide Editor

This select annotated guide to energy education resources was compiled by the staff of Massachusetts Audubon Society's Education and Public Policy Department under a contract with the Massachusetts Executive Office of Energy. The selections and omissions do not imply any endorsement by the State agency but are judgements of the MAS staff. The selections cover materials produced through 1986.

ENERGY EDUCATION
WHY, WHEN, AND WHERE

Energy runs the world. Without it nothing would get done; without a sound understanding of it — the sources, the unequal distribution and availability of much of it, the ways it is transported and used, and the political implications of wasting it — we cannot lead informed and effective lives. Obtaining and supplying energy generates pollution and other problems. Citizens need to understand this in order to make intelligent choices in the market place and voting booth; choices that will permit them to acquire sufficient energy to fulfill their needs and desires while maintaining an environment fit for life.

Education about energy must be part of the core of our efforts at schooling; not as a separate topic, but as an integral part of many disciplines where it is most appropriate. It should be infused throughout the curricula over the span of the school years. When energy education is mentioned there is a tendency for people to think — science. To be sure, there is a significant science component to energy education, but there is an equal role to be played by the social sciences in helping youngsters learn about the geography of energy sources, the history of energy use, the development and implementation of energy policy, and the skills of civic action. Home economics programs need to help students understand food energy and how to determine energy use of various appliances so that they can conserve both energy and dollars. Similarly, industrial arts programs should be helping students explore the energy requirements of tools and construction processes and how they can be reduced. Even sports programs can make a strong contribution by helping youngsters learn how to eat properly and make the most effective use of that food energy in any particular sport.

Awareness and understanding of energy and its role in our lives cannot be confined to academic disciplines if it is to be effectively taught. It must permeate the whole school environment. Energy conservation for the school building should be discussed and practiced by everyone, not just the custodian. Opening and closing of shades at the beginning and end of the school day, dressing appropriately so that thermostats can be set lower, shutting off unneeded banks of lights near windows and other such practices when discussed and routinely carried out, can establish and maintain an energy consciousness. In school field trips to learn about the operation of the school's energy systems — electrical, heating, food preparation — can be useful. Don't neglect to note design flaws that have made significant energy conservation difficult. Have students suggest how things might have been done better. Where feasible the students may even become involved in making energy saving changes, or at least recommending them. Students in Wallingford, Connecticut made recommendations that over two years saved the schools there more than 400,000 gallons of oil and over 3 million kilowatt hours of electricity. By investing $12,000, the schools there saved over half a million dollars.

Some teachers feel uncomfortable about undertaking energy education with their kids, feeling that their own education has left them ill prepared to do an adequate job. They find the texts they are using offer little about energy, particularly the non-science texts. ***It is unfortunate that society has taken so long to realize publicly the fundamental importance of energy to our lives and the need to have all future citizen basically informed about energy and its role in our lives.*** That delayed realization has put an added burden on society which must now pay a premium price for past failure and it puts a burden on educators who now must scurry about to address this educational deficiency in order to help correct society's energy mismanagement.

However, the sense of inadequacy felt by those teachers is generally ill founded; most already know much more about energy than they think they do, and with a little additional instruction they can do a creditable job of energy education. Of course, the more teachers learn about energy the better able they will be, not only to teach students but to manage and conserve energy in their own homes. Learning more about energy therefore has a double payoff.

An effective energy education program has to be based on a school-wide development and implementation plan. Materials must be examined, reviewed and selected; inservice workshops for teachers need to be planned and scheduled; a multi-year implementation schedule established and monitored with clear-cut objectives and evaluation guideposts. Energy education should be a warp thread woven into the school's overall curricula. This entails considerable work, but proper management of energy is so important to our society, now and for the future, that we must make the investment of time and effort. ***All the major teacher's organizations, administrator's organizations, and the association of school committees have produced formal statements favoring energy education. It is now time to move these statements from letterhead pieties to action programs.***

ENERGY EDUCATION — WHAT

Instruction about energy and its role in society is a developmental effort that needs to occur over a span of many years. The basic concepts and related skills are not learned all at once. This resource guide is focused on grades 10, 11, and 12 and on the skills and energy concepts that seem to be most appropriate to the cognitive, affective, and skill development levels of youngsters in that age range. Students at this stage of their lives are nearly adults, and they should begin to develop skills that will help them deal with energy issues when they leave high school. At the same time, high school students should be learning methods of inquiry and decision making and means of acting on their information. Energy education is one vehicle for helping these students with some of the tasks of high school level intellectual growth such as:

- *developing abilities to collect, examine, and criticize information.*
- *developing disciplined and logical thought processes.*
- *developing the ability to communicate ideas and feelings through listening, speaking, reading and writing.*
- *developing ability to use their schooling in their personal lives.*

OBJECTIVES FOR UPPER SECONDARY LEVEL ENERGY EDUCATION

Objectives for a high school energy education program fall into three primary categories: knowledge objectives, participation objectives and imagination objectives (those that challenge their mental abilities at imagery). The following set of such objectives may prove useful in planning your program.

Knowledge Objectives:

1. Students will acquire basic concepts of energy conservation, resources, and interdependence.
2. Students will acquire basic concepts of self and human behavior.
3. Students will acquire knowledge of basic processes of energy transformation and use.
4. Students will acquire basic knowledge of policy processes affecting energy decision-making and the impact of various alternatives.

Participation Objectives:

1. Students will learn basic steps in individual decision-making including information, choices, alternatives, applying values to alternatives, and determining consequences.
2. Students will experience individual decision-making in group settings in their school, home, and community related to energy conservation.
3. Students will develop skills in group decision-making, including identifying rules and appropriate strategies, implementing group decisions, and identifying consequences.
4. Students will gain experience in acting in group situations in their school, home, and community related to energy conservation.

Imagination Objectives:

1. Students will develop images of energy situations from their own personal experiences.
2. Students will share concrete descriptions of their images of energy situations with other students.
3. Students will use concepts to describe their imaginary situations, and share those with other students.
4. Students will apply the concepts they develop to their own everyday lives.

MAJOR ENERGY CONCEPTS

To facilitate selection of content material for secondary school energy education the following list of energy education concepts is provided. These are adapted from those developed by the North Carolina energy curriculum. They are clearly not the only statement of such concepts but they provide a reference frame for developing your own local program.

The eleven concepts presented in bold-face below represent a core to be developed in the three-year span of grades ten, eleven, and twelve. To develop them adequately with the learners will require input from several of the basic disciplines taught in these grades — science, social studies, and mathematics. Sub-concepts listed beneath the major ones are keyed to areas that seem most appropriate to deal with them, not only the major disciplines noted but home economics and industrial arts as well. Code: **S = science; SS = social studies; M = mathematics; HE = home economics;** and **IA = industrial arts.**

1. Energy is Required for Change. . .Biological and Physical.

1.1. Energy is the ability to produce motion or cause a change; it is the ability to do work. **[S]**

1.2. All living things require energy to carry on life processes (photosynthesis, respiration, metabolism). **[S]**

1.3. Atmospheric circulation is partly caused by the unequal distribution of solar energy. **[S]**

1.4. Forces of gravity and magnetism bring about changes on earth such as ocean currents, tides, and movements of air and water. **[S]**

1.5. Changes in matter can be either physical or chemical, but it takes some form of energy to induce them. **[S]**

2. Matter and Energy, Under Normal Conditions, are Neither Created Nor Destroyed, but Can Be Converted from One Form to Another.

2.1. Potential energy is energy at rest while kinetic energy is energy at work. **[S]**

2.2 There are many forms of energy such as heat, light, sound, electrical, mechanical, and chemical. **[S]**

2.3 Energy changes form in many ways as it passes through the bodies of living things and on through food chains and webs. **[S,HE]**

2.4 Energy changes form in many ways as it is used in machinery and industrial processes. **[S,SS,IA,HE,M]**

2.5 Light energy is converted to heat energy in the atmosphere and at the earth's surface. **[S]**

2.6 Through photosynthesis, light energy is used to change carbon dioxide and water into food molecules with chemical energy which organisms can use. **[S]**

3. When Energy is Transferred from One Form to Another, the Amount of Useful Energy is Reduced.

3.1. No machine is 100% efficient because in transforming one energy form to another some heat is generated which is not directly useable for the purpose of the machine. **[S]**

3.2. Efficiency of any machine affects the amount of energy needed to do a job and therefore the cost of operating the machine. **[HE,IA,S,M]**

3.3. In the flow of energy from the sun through the various steps (trophic levels) in food chains and webs, some useful energy is lost at each point of transfer. **[S]**

4. The Sun is the Primary Source of Energy for the Earth.

4.1. The sun is the initial source of energy in an ecosystem. **[S]**

4.2. Most energy sources can be traced back to the sun (e.g. wood, fossil fuels, wind, hydro, fission). **[S]**

4.3. The sun supplies us directly with various forms of radiant energy that are used directly or converted to other energy forms. **[S]**

4.4. The energy from the sun is responsible for most of the processes on earth such as weather phenomena, the water cycle, the carbon cycle, climatic conditions, and seasonal changes. **[S]**

4.5. Fusion is the principal process by which energy is produced in the sun. **[S]**

4.6. Energy produced on the sun, or other stars, travels through space as electro-magnetic waves. **[S]**

5. The Use of Energy is Necessary for the Operation and Survival of Any Society.

5.1. Since prehistoric times people have used fuels, in addition to food, to generate heat, light, and power and they will continue to do so in the future. **[SS]**

5.2. Throughout history cultures have periodically faced crisis in availability of their culturally dominant fuels. **[SS]**

5.3. Societies vary in their perception of acceptable fuels based in part on availability, cost, and ease of handling. **[SS,HE]**

5.4. Rates and amounts of energy consumption vary from country to country. **[SS]**

5.5. Industrialization depended upon the development of a number of inventions that could generate concentrated power from available fuels and harness that power to do useful work. **[S,SS,IA]**

5.6. Life style decisions affect energy consumption and energy-related decisions may heavily influence life style options. **[SS,HE,IA]**

5.7. Access to energy supplies affects the nature and success of all biological communities. **[S]**

6. All Sources of Energy are Limited in Some Way (Availability, Practicality, Application) and, Therefore, Pose Unique Utilization Problems.

6.1. Energy sources are not evenly distributed around the earth. **[S,SS]**

6.2. Forms of energy usable by organisms and ecosystems are limited. **[S]**

6.3. Living organisms solve problems in the utilization of energy by their special adaptations. **[S]**

6.4. Different energy sources are used for different jobs. **[S,HE,IA]**

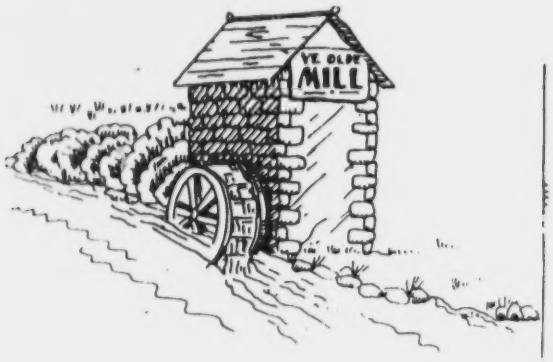
6.5. The different energy sources generate a variety of pollutants in varying amounts which, depending upon their concentrations, longevity, and properties, affect human and other natural communities.**[S,SS,HE,IA]**

6.7. Solar energy tends to be diffuse and difficult to harness for use on a large scale though reasonably practical on a small scale for certain uses. **[S]**

6.8. Fossil fuels are formed by the sedimentation and metamorphic processes of the earth and are therefore finite and non-renewable on any human time scale. **[S]**

6.9. Hydroelectric generation of adequate amounts of power is limited by location of major natural rivers in suitable topography. **[S,SS]**

6.10. The use of tidal, wind, and geothermal energy sources depends heavily on location and the location's environmental factors. **[S,SS]**



7. Presently, Most Energy Requirements in Developed Nations are Met through Using Fossil Fuels (Coal, Oil, and Natural Gas) Which are Finite and Not Renewable on Any Human Time Scale.

7.1. Most electricity is generated using fossil fuels. **[S]**

7.2. Transportation modes using internal combustion engines depend primarily on fossil fuels to provide energy. **[S,SS]**

7.3. Fossil fuels are also in demand as raw materials for fertilizers, synthetic fibers, plastics, and medicines which sometimes raises a demand priority conflict for a scarce resource. **[S,SS]**

7.4. The supply of fossil fuels that we are using now was formed thousands of years ago. **[S]**

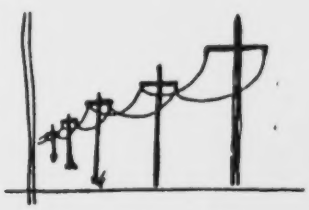
8. Alternative Sources (Direct Solar, Wind, Hydro, Biomass, Tidal, Fission, Fusion, and Geothermal) to Fossil Fuels are Available for Development to Meet Long-Term Energy Needs.

8.1. Development of alternative energy resources depends upon technological feasibility, geography, availability of investment capital, and cultural acceptance. **[S,SS]**

8.2. A number of solar related alternatives, such as wood and other biomass technologies, wind, and active and passive solar collecting devices are available today for small scale uses. **[S,SS]**

8.3. Young people growing up today have an opportunity to play key roles in the technological development and refinement of sustainable energy alternatives. **[S,IA]**

8.4. Each energy technology has negative impacts on the environment, and decisionmakers must make choices based on tradeoffs between legitimate energy demands and estimated environmental and human health degradation.**[S,SS,HE,IA]**



9. The Development, Distribution, Conversion, and Use of Energy Result in Environmental, Political, Economic, and Social Consequences.

9.1. An interrelationship exists between increased technology and energy consumption. **[S,M]**

9.2. Trade-offs must occur if conflicts among ecologically-sound practices, economic feasibility, political interests, and energy demands are to be resolved. **[SS]**

9.3. Geographical, environmental, and economic factors of a specific location influence the choice of the most viable energy source. **[SS]**

9.4. Unequal distribution of energy resources (particularly fossil fuels and wood at this time) causes major economic and social consequences for the "have"and "have not" nations. **[SS]**

9.5. Costs of energy resources are dependent upon availability. **[SS]**

9.6. Many causes of pollution (air, water, soil) are the results of substances being released into the environment during energy production and use.**[S]**

9.7. Overuse of the earth's resources (renewable and non-renewable) may have negative consequences for the quality of life and the environment's capacity to sustain our populations. **[S,SS]**

10. Energy Conservation will Extend the Availability of Energy Resources.

10.1. Improved technologies for extracting, processing, and utilizing energy resources such as coal, oil, and natural gas may help conserve our finite supplies of such resources. **[S,SS]**

10.2. Changing wasteful energy-use habits can reduce demand and thus extend finite energy supplies. **[S,SS,HE,IA]**

10.3. Energy conservation involves increasing energy efficiency and decreasing the amount of energy used. **[S,HE,IA]**

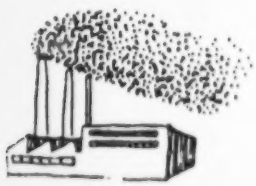
10.4. Energy conservation is an individual and community concern. **[S,SS,HE,IA]**

10.5. Products should be evaluated on the basis of energy efficiency. **[S,HE,IA,M]**

10.6. Recycling materials frequently conserves both energy and materials. **[S,HE,IA]**

10.7. Factors of community energy consumption can be influenced by committed individuals and groups. **[SS]**

10.8. Proper preventative maintainance of cars, mowing machines, home insulation, etc. helps conserve energy. **[S,HE,IA]**



11. The Needs, Attitudes, and Values of the Individual and Society Affect the Use of Energy.

11.1. Humans may choose to exploit or live in harmony with their environment. **[SS]**

11.2. The price of poor energy use today is paid in the future usually by a succeeding generation. **[SS]**

11.3. Future options of a society depend in large measure on energy use decisions made today. **[SS]**

11.4. Attitudes toward energy use and conservation vary with individuals. **[SS]**

11.5. Energy-related value decisions can be made based upon knowledge of available options and their potential consequences. **[SS]**

As overall, learner-directed goals for energy education it is anticipated that learners should understand that:

- there are many sources of energy.
- energy can be converted from one form to another.
- energy resources and their availability for human activity vary.
- there are many uses of energy.
- there are wise and efficient management practices which can extend the useful life of the earth's energy resources.
- energy development and use create impacts on environmental and economic systems.
- our energy future may be different from that of the past or present.

CURRICULUM INFUSION

Although high school teachers may recognize the need for, and may even desire, instruction about energy and its role in society, adding new topics to the high school curricula is often very difficult. High school teachers are expected to prepare students for college, to broaden student awareness of possible careers, and to deal with whatever problems the community deems important: drug education, academic testing, upgrading graduation standards, computer literacy, etc. The last thing most teachers want to hear is that another topic must be squeezed into their full teaching schedule.

Energy education, however, need not take place in a separate unit crammed into an already full curriculum. Indeed, a class or unit devoted to energy may not be the best educational strategy. By focusing exclusively on energy, students may lose the perspective that energy concerns are connected to all areas of high school study: history, economics, communication, and science. Alternately, energy awareness can be developed when energy-related concepts are infused into existing courses where appropriate. A teacher can expand a basic topic with a brief mention of how an energy concept applies to the lesson. For example, a teacher in an American History class studying westward expansion might ask the students, in addition to their basic study, to examine the importance of various energy sources during that period. A list of these might include wood and coal used in trains and for heat, wood for cooking, human and animal muscle power in agriculture, coal in steel making, and falling water of river currents making raft travel possible.

Other possible topics for infusing energy ideas are listed below by typical course content. The list is a starting point; creative teachers will find many other areas where energy ideas may be included in the context of existing lessons.

WORLD HISTORY/WORLD CULTURES

Subject and topic	Energy related study question
Life in other cultures	What energy sources are or were used for cooking, transportation, and other activities?
Ancient Civilizations	
Development of animal power and other labor-saving devices	How did Egyptian farmers obtain irrigation water from the Nile?
Agriculture	How might this be considered the first capture of solar energy for human needs?
Architecture	How were ancient buildings provided with light and heat?
Geography	
Geography influences climate	How does climate affect the energy needs of people?
Topography influences how land will be used	Why were factories located near rivers and flat areas preferred for farms?
Availability of resources	Where are major sources of energy found around the world?
Modern Life in other countries	
Economics	To what extent does the country's economy depend on energy revenues?
Industry	How does the availability of energy supplies affect the type and concentration of industry?
International trade	What percentage is energy related?
Problems facing other countries	Why is a shortage of firewood the foremost energy concern in many countries?

ECONOMICS

Subject and topic	Energy related study question
Basic principles	How does the price of oil from 1970 to the present illustrate many important principles of economics?

AMERICAN HISTORY

Subject and topic	Energy related study question
Colonization	What sources of energy were used in cooking, lighting, farming, and in trade?
Westward expansion	How did changes in energy use, e.g. from wood to coal or the development of labor-saving machinery, help make westward expansion possible?
Industrialization	How did energy use change during this period?
Post World War II America	
Growth of suburbs	How did the price and availability of energy supplies for transportation and home heating contribute to their development?
Prosperity and affluence	How did the increase in spending power effect the use of electricity?
Migration of farmers to cities	How did fossil fuel use on farms change as fewer farmers produced more food?
"Sunbelt" migration	How did the cost or discovery of energy sources contribute to the 1970s and 1980s population shift to the west and south?

PROBLEMS IN MODERN SOCIETY

Subject and topic	Energy related study question
Pollution and acid rain	How does the use of energy contribute to pollution?
Shortages of resources	What is the outlook for fuel supplies?
Food supply/world hunger	How important is the availability of fossil fuels to large scale agriculture?
World trade/economic development	How does the price of energy affect the balance of trade and development in less developed countries?

BIOLOGY

Subject and topic	Energy related study question
Photosynthesis	How is a leaf similar to a solar collector?
Food chains	How is the food web pyramid of animals and plants similar to and different from the human food production system?
Respiration	How is energy used in the body?

ENGLISH/COMMUNICATION

Subject and topic	Energy related study question
Reading the newspaper	How do the news media present energy information to the public?

HOME MANAGEMENT

Subject and topic	Energy related study question
Household budgetting issues	How can residential energy use be reduced?

ENERGY EDUCATION THROUGH BASIC SKILLS

Another means of increasing students' energy awareness is to use energy related examples to teach the skills and content normally covered in a course. With this approach, energy awareness is increased while achieving other objectives. For example, if the objective is to teach students to interpret graphs, using graphs dealing with energy supply will accomplish the same purpose as any other graph plus the students will also learn about energy. At the same time, students will see greater value in learning a skill because they will see how it can be applied to problems they may deal with in their lives.

The following are representative skills that may be developed using energy as a theme:

- research methods
- using the library
- critical thinking
- identifying news media bias
- note taking
- separating fact from opinion
- reading charts and graphs
- interpreting data
- preparing reports
- communicating ideas and information

Similarly, simulations based upon energy examples might be used to reinforce basic concepts. For example, students studying the process by which a bill becomes a law may gain greater understanding of the process by acting out hearings and listening to testimony of interest groups. If the bill focused on an energy topic, the mock hearing would increase overall energy awareness along with understanding of the legislative process. The following are examples of topics for which energy-related simulations or exercises may be used to reinforce basic concepts:

- How a bill becomes a law
- Congressional hearings
- Household financial management
- Principles of economics
- Distribution of global resources

These are only examples from many that could be chosen to illustrate how many concepts can be dealt with in only a small addition to a traditional unit. By such means a great deal of sound energy education can be woven into the overall high school program. The resource listings that follow give detailed information on hundreds of activities that can be utilized to build an energy education program that fits the needs of your classroom and school. Through careful planning you can use them to assure a citizenry of the future much better informed and aware of the role of energy in their lives and alert to problems and opportunities generated by energy utilization in any culture, past, present, or future.

100 ENERGY EDUCATION ACTIVITIES

The following is a list of energy education activities you might want to use with your classes or share with other teachers in your school. The ideas were originally prepared and distributed to teachers in the National Energy Education Day network (page 47) and have been slightly revised for inclusion here. The 100 ideas serve as good examples of the breadth of activites that can be used to teach about energy. You may find included in the list suggestions that are applicable to your classes or that inspire other teaching strategies.

General

1. Compare the use of energy in America with the use of energy in other countries. Compare total energy use by economic sector (industrial, transportation, residential/commercial) and by the kind of fuel (primary fuel--coal, oil, hydro-electricity, nuclear power, gas).

2. Summarize energy resources by country. On a world map modify the size of each country to match the amount of its resources. Use a separate map for each resource. When the maps are finished, they should show which countries have more--or less-- of a particular resource. Do maps for oil, coal, and natural gas. Make another set of maps for amount of energy used per country. (If you are unfamiliar with this type of map, see e.g., The State of the World Atlas.)

3. Describe how your community uses energy, where the energy comes from, and where it goes.

4. Organize a debate on a particularly challenging energy-related topic such as, "The wasteful use of our non-renewable fuels is a crime against future generations of Americans." Try to pick a debate topic that will arouse strong feelings.

5. Use maps or make an atlas of the United States to identify the energy resources in each of the following regions: New England states; Mid-Atlantic states; South-Eastern states; North-Central states; South-Central states; Plains states; Mountain states; and Pacific states (including Hawaii and Alaska). Energy resources include coal, oil, natural gas, oil shale, tar sands, geothermal, solar, wood, wind, hydropower. (A good reference for this is the United States Energy Atlas, 2nd edition, Macmillan publishing company.

6. As a class, decide on a familiar object and trace the object back to its beginning as raw material. List all of the kinds of energy used in the object's production, including transportation. Have the class show their findings on a chart.

7. Compare the heat content of various fuels. For example: several different oil products (gasoline, kerosene, fuel oil, or white gas), wood, coal, and peat. Or compare heat contents of items not directly fuel related, such as paper, plastic, and foods.

8. Investigate and prepare a presentation on various energy-related careers, such as petroleum or coal engineers, geologists, solar engineers, solar installers, miners, nuclear physicists, nuclear plant operators, and electrical plant operators.

9. Discuss how energy flows through biological systems; through the food chain or through a single plant or animal. Contrast this with how energy flows through a society. Compare energy flow through a primitive society with energy flow through and advanced technological society.

10. Have students (individually or in groups) interview people who are old enough to remember what life was like before the days of plastics, TV, jets, cars, and other common, technologically sophisticated items. Before the interviews, have students decide on a series of questions, such as:

    a) How was your home heated:
    b) What kind of fuel did you use for heating and cooling?
    c) What did a work week consist of in days and hours? How much did you get paid?
    d) How did you get to work?
    e) How did you get to school?
    f) Did your family own a car? If so, do you remember the brand name of your family's first car? How much did it cost?
    g) What kinds of entertainment did you enjoy?
    h) How did you buy the necessary things: food, clothing, medicine, etc.? What items were considered "necessary" then? How do they compare to today's "necessary" items?
    i) What was clothing made of? How did you do your laundry?
    j) How did you heat bath or laundry water? What were soaps like?
    k) What were the eating facilities in your school? The bathrooms? What did you have for school supplies?
    l) Today, plastics are used for much of our packaging. What did you use?
    m) How did you keep food from spoiling?
    n) How was your home lighted?
    o) Did your family go on vacation? Where and how did they go? What were roads like then?
    p) What happened to your old schoolhouse? How did school change with the coming of school buses?
    q) How do you think the car changed things in your town or city?

    Have the class compile the reports, discuss the findings, and complete a class display on the topic: "The good old days--Or were they?"

Thermodynamics

11. Report on the Energy Laws: The First and Second Laws of Thermodynamics.

12. Show how energy is lost in converting it from one form to another. What happens to this lost energy? Define efficiency. Could a system be 100% efficient?

13. Report on hypothetical examples of perpetual motion machines. Describe each type of proposed machine and analyze why each machine would eventually stop. If a perpetual motion machine could be made, how would that affect the long term outlook for energy supplies?

History

14. Organize a field trip to a local museum (e.g. Old Sturbridge Village) to view exhibits on Colonial America. Help the class notice how different the technology was and how energy was used differently--looms, spinning wheels, other farm and household implements, etc. Have your students contrast these items with their modern counterparts. Ask: How has technology changed? How has energy use changed?

15. Divide the class into groups to present then/now reports on the following topics (use colonial period--industrial age--present day):

    a) Supply of energy resources.
    b) Machine vs. hand labor and how each relates to energy use.
    c) Wages, hours, vacations, benefits of American workers and how they are affected by energy use.

16. Construct a time line depicting energy-related events and availablity of energy sources since 1970.

17. Trace the role coal (or wood, oil, natural gas, electricity) played in the development of the United States. How was this resource used in the 18th century? How has its use changed? What new technologies have been developed to use this resource?

18. Build a model of an early factory. Describe the types, uses, and operation of the machinery, and the sources of energy for this factory. Contrast the energy use of this early factory with that of a modern factory. How has the treatment of production and waste products changed?

19. Have students construct an energy time line showing important technological developments, inventions and inventors, and discoveries from pre-history to modern times. Have students research the ways each development increased energy use or influenced what kind of energy was used.

20. Have your class create a display of thumbnail energy "biographies." Have them display pictures, drawings, charts, diagrams, and written explanations of the important energy sources. Students should treat these energy sources as if they were people and give their history.

Economics

21. Investigate the effects of energy prices on our everyday lives. Divide the class into five groups and assign each group one of the following topics: a)people living on fixed incomes; b)gap between rich and poor people; c)growth of cities, suburbs, and small towns; decline in the rural population; d)population growth; and e)changes in lifestyle. Have each group conduct interviews with community members and report what changes the group foresees for their topic or situation as energy prices change.

22. Report on the way energy is bought and sold as a commodity. Research the price of various forms of energy. How does the price affect the supply?

23. Study and report on how changing energy prices affect: a)the profits of energy companies, b)the prices consumers pay for things other than energy.

24. Report on the energy problems confronting developing nations. How can they afford fossil fuels when competing with richer developed countries?

25. Investigate the shortage of fuels in Third World countries. What is the "firewood crisis?" How is increasing desertification related to shortages of wood?

26. Study OPEC: What is this cartel, how does it affect western industrialized countries, and how does it affect developing nations? How does it affect the world economy? Why was the cartel originally formed? Do you think it has achieved its purpose? How has its influence changed since 1970?

Consumption

27. Construct flowcharts of the energy input and output of agricultural systems. Compare early farms with modern industrialized farms.

28. What kinds of energy do you use in your home? How much do you use per year, per month, per day? Show how technology has changed the type, amount, and rate of energy consumption in your home.

29. Prepare a classroom display on how your community's energy use has grown. Have students collect pictures, maps, artifacts and information on your community's energy history. With your students, examine changes in technology and growth patterns in population and industry that have influenced energy use over the years. Have your students examine trends and make projections for the future.

30. Have your students keep track of their use of non-food energy for a week. Ask them to discuss essential and non-essential energy uses.

Production and Distribution

31. Contrast centralized and decentralized systems of energy distribution. What is the difference? What are the advantages and disadvantages of each system?

32. Have your students map your school's energy system showing how heat travels to your classroom from the boiler room and the air conditioning and electrical connections in the building. Enlist the help of the custodian. Have students consult with the custodian of your school and make a classroom chart showing the types of energy used in your school, how the energy gets there, where the energy is stored, how the energy is used, and places where energy is wasted or lost. How could the lost energy be recovered?

33. Compare the various kinds of power plants: oil, coal, hydro, nuclear. Build models of the electrical generators in these plants.

34. Make a list of local sources of energy that you could rely on if world supply lines were cut.

35. Describe and demonstrate the various ways that energy can be stored.

36. Investigate methods of transporting energy. Which are the least expensive? Which are the easiest? Which methods could be used for several different forms of energy.

37. Show the steps involved in getting coal, oil, and/or gas from mine or wellhead to market.

38. Build a model of a supertanker. Show where the oil is located and how much oil each supertanker can hold. How are supertankers loaded and unloaded? Discuss the precautions that must be taken to prevent spills.

39. Report on cogeneration (the simultaneous generation of electricity and heat by utilities and industrial plants). Find examples in your community of current opportunities for cogeneration.

40. Ask representatives of energy organizations (such as a utility) to come to your classroom for a panel discussion. Ask each speaker to explain what their organization does and what kind of services is provides. Have students prepare questions for each panel member in advance. Have the class decide on one problem or question for all panelists to discuss.

41. Organize a field trip to an electric generating station. If possible, plan to follow the power lines from the school all the way back to the power plant. After the field trip, have students report on the following: a)the processes involved in generating electricity; b)the role of transmission lines; c)the advantages and disadvantages of electricity as a power source.

42. Trace oil trade routes on a globe or wall map.

Transportation

43. Compare the energy used per passenger mile for automobile, bus, train, trolley, subway, and airplane. Discuss the advantages and disadvantages of using each system.

44. Prepare a presentation on energy conversions in the automobile. Show the important conversions from energy source to intermediate form to end use. Point out places in the automobile where these conversions take place.

45. Build a model flywheel and describe how it stores energy.

46. Build a "Car of the Future": and electric, battery-powered or solar-powered car, a car that can run on methane, alcohol, or hydrogen, or develop new ideas.

47. Build a model of a steam engine and show its uses and operation. (Or build a model of a steamboat, or steam locomotive).

48. Hold a mock trial in which your class puts the automobile on "trial" because it has been accused of not "earning its keep" in terms of its contributions and in light of its disadvantages.

49. Discuss the consequences of automobiles on: a)where we shop and work; b)where we live; c)our use of leisure time; d)our energy consumption. How would mass transit systems change these?

50. With your class, keep a log of all trips made with the automobile for two weeks. Have your students determine how much gasoline was used in the two-week period and calculate the cost in dollars. Also in $/mile. Have the class list those trips that could have been made using other means. Discuss how much energy could have been saved.

51. Draw maps of mass transportation in your community. Calculate how much using mass transportation helps save energy.

52. Investigate the possibilities of building bicycle paths in your community. How would this reduce energy consumption?

Conservation

53. Prepare a display on energy conservation reminders for home and school. Include the many ways to conserve gasoline.

54. Determine the ways heat is being lost in your home or school. Make a list of suggestions on how to keep heat where it is most useful. Have your class test the insulating ability of several materials. Determine which materials are the best insulators. (High schools might be interested in the STEM program described elsewhere in the resource guide.

55. Gather information and report on new methods of insulation, new technologies for space heating (such as heat pumps, solar heating, radiant heating, and high efficiency furnances, etc.) and other ways of using less energy in buildings.

56. Have your class measure the accumulation of trash in one school day. Have your students list what kind of trash could be reused and what could be recycled or used more efficiently the first time. Estimate how much energy is lost in the portion of trash that cannot be recycled.

57. With your class, compile a list of common household articles that use electricity. Then set up an attitude questionnaire that would show how people feel about doing without particular electrical appliances. Have your class fill out the questionnaire and compile the results. Then have the students take the questionnaire home and have their parents complete it. Compare these answers with the peer group survey.

58. Bring some electrical appliances to class (or have students bring them) and identify the features on the appliances that use extra energy. Discuss with your class the tradeoffs of each feature in terms of convenience, operating costs, and extra energy consumption.

59. Contract conduction, convection, and radiation--how do they relate to the insulation of your house? The cost of heating a building? How are these forms of the movement of heat used in passive heating systems?

60. Study district heating or cogeneration. How is energy conserved in these systems?

Fossil Fuels

61. Show how oil and natural gas were formed. In what geological formations can they be found?

62. Using an outline map of the world, show where oil spills have occurred in the past. Show the direction of travel of the oil slicks and how they spread. Put on the map the names of the tankers and the amount of oil spilled. As a demonstration, create an oil slick in a pan of water. Show why slicks are often difficult to clean up. Demonstrate new technology that has been developed to clean up spills effectively.

63. Have students collect current newspaper clippings dealing with pollution from the extraction, transportation, and use of fossil fuels, and make a bulletin board display.

64. Design and conduct a scavenger hunt for products made from coal or oil. First, draw up a list of familiar coal or oil based products and discuss them with the class. Then conduct a scavenger hunt.

65. Draw a geological time line emphasizing periods of coal formation. What was life like during these periods? What were the world climatic conditions? Are there areas of the world where coal may be forming today? How long would such formation take?

66. Study the various grades of coal: peat, lignite, bituminous coal and anthracite. Show on a map of the U.S.A. where each of these is found.

67. Build a model of a strip mine. Show how the coal is extracted and the land reclaimation process.

68. Compare the properties of petroleum, kerogen (in oil shale) and bitumen (in tar sands).

69. Have students present brief written or oral reports on books that center around the effects of extracting and transporting fossil fuels. (One to consider is How Green Was My Valley, by Richard Llewellyn.)

70. Stage a mock panel presentation or interview with an "environmentalist," a "government representative," and a "representative from a utility." Tell the rest of the class that they are farmers who have all been told that there is coal on their lands. They have come to listen to these speakers present their sides. If desired, videotape the hearing.

71. Study the structure of our hydro-carbon fossil fuels. Build models of petroleum molecules. How are various products, such as motor oil, gasoline and diesel, refined from crude oil?

72. Contrast the various oil or coal products Americans used in the past with oil and coal products in use today.

73. Show and discuss the many uses of natural gas. Research unconventional sources of gaseous fuels, such as coal, plants and organic wastes.

74. How can oil be stored underground (strategic reserves)?

75. Study acid rain--what is it, where does it come from, what are its effects? Study the effects of acid rain on the ecosystems of lakes.

76. Study the long range and global effects of the buildup of CO_2 in the atmosphere caused by the burning of fossil fuels. Why is this called the "greenhouse effect?"

Nuclear

77. Discuss the history of nuclear energy.

78. Research and report on current experiments into nuclear fusion. Prepare a display chart illustrating a theoretical fusion reactor and explain its operation. Prepare a flow chart of fusion reactor operation and show the energy conversions.

79. Study the general characteristics of nuclear power generation (fission). Describe the operation of a nuclear power plant and discuss the advantages and disadvantages of nuclear power. Compare and contrast fission and fusion--processes, technology, problems.

80. Build models of geological formations that could store nuclear wastes.

81. Show how fuel is produced from uranium. Show how much energy is lost in the processing steps from raw uranium to fuel pellets for a reactor.

82. Show characteristics of radioactive atoms: structure of uranium, plutonium, etc. Investigate the nature of radioactivity.

Solar

83. Investigate historical applications of passive solar architecture such as the houses of the Pueblo Indians or New England salt boxes.

84. Build a model of a house utilizing an active solar power system. Compare it with a model of a house utilizing a passive solar system.

85. Make up your own solar space heating system. Be sure to allow for collection, storage, and distribution components. Or make up your own solar hot water system.

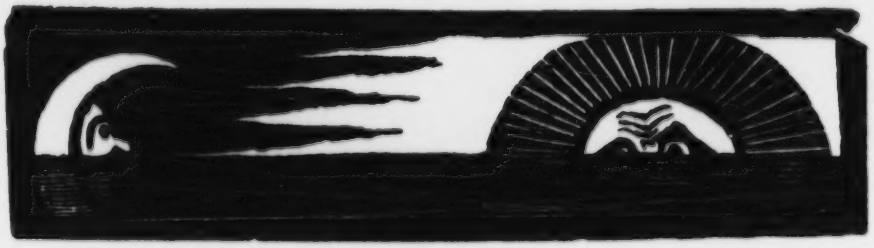
86. Show and discuss how photovoltaic cells work and the feasibility of their use.

87. Build a model of a solar power tower. Describe its operation and show how mirrors can be used to concentrate the sun's rays on a tower boiler.

88. Build a model of a solar farm and describe its operation and feasibility.

89. Study the process of obtaining solar energy from the sea. Build a model of an OTEC (Ocean Thermal Energy Conversion) floating power plant. Discuss its operation and feasibility.

90. The sun is the origin of most of the energy on earth. Trace the various fuels back to their solar origins. Try the fossil fuels, wind, wood or other biomass, and hydropower.

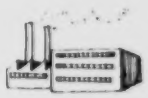


Alternate Energy Sources

91. Have students read and report on science fiction stories that describe new or future energy sources.

92. Have your class investigate "new" energy resources. Divide the class into groups and have them read about and explain some of the scientific principles underpinning the new energy sources listed below:

    a) Solar Energy (space and water heating)
    b) Wind
    c) Geothermal, Geopressured zones
    d) Biomass
    e) Coal gasification and liquefaction
    f) Oil shale/tar sands
    g) Fusion
    h) Magnetohydrodynamics



93. Discuss ways of harnessing energy from tides.

94. Compare the economic, environmental, and energy advantages and disadvantages of conventional energy sources with alternative energy sources (solar, wind, biofuels, synfuels, hydro, wood, etc.)

95. Discuss and/or demonstrate how to produce energy from biomass (plants, trees and organic wastes). What is gasohol?

96. Design a class experiment that will show how heat content varies with various kinds of wood.

97. Discuss world ramifications of growing crops for fuel instead of food.

98. Find out if there are local plants that could be sources of biofuels. Study the cultivation of: jojoba, kelp, euphorbia, guayule and water hyacinths. Describe these plants and where they are found.

99. Discuss how geothermal energy can be extracted and put to use. Show on a map the places where geothermal energy is currently being used. What does this tell you about the structure of the earth?

100. Build and contrast models of old and new windmills, and discuss the past and present uses of wind energy. Map U.S. wind patterns--point out the best areas for using wind power. Research minimum and maximum mph requirements.

ENERGY EDUCATION — HOW

Beginning in the mid-70's a considerable amount of energy education material was generated for all levels of education. In the haste to get out educational materials to meet the perceived energy crisis, a fair amount of the material left much to be desired educationally. As time passed much better materials were generated but funds to make them available dwindled as the "energy crisis" appeared to abate. The result is that some good, widely recommended materials, are no longer available. All of these things were considered in compiling this guide which deals with materials produced through 1986. For this guide, selection of the resources (including books, brochures, games, audio-visuals, computer soft-ware, and field trips) was based on the following criteria:

- Useability in an instructional atmosphere, that is, the material should be suitable for use by teachers and students in both formal and non-formal classroom settings.
- Relevancy to issues on energy use in the environment.
- Accuracy and up-to-dateness of energy facts and trends.
- Attractiveness of format, organization, illustrations and resources.
- Emphasis on curriculum material that calls for active student participation, both in and out of the classroom, and assumes little teacher background in most cases.
- Emphasis on energy conservation and quality of life.
- Availability, that is, teachers have easy access to all resources included in the guide.

Reviewers of the material were all experienced teachers and teacher trainers; furthermore, energy scientists read the material for technical accuracy. An advisory panel of five local and national energy education specialists and school teachers reviewed our final sections to be sure we had not overlooked some particularly valuable material or included materials grossly inappropriate to the grade levels.

The first part of the **How** materials focuses on what are considered the top materials appropriate to this grade range. Each of the selections is quite comprehensive in its scope and as a group they represent a range of approaches to energy education. With these **Top** programs you will find a comprehensive summary sheet that uses a checklist format to supplement the review. The summary sheet also includes a photostat of the cover graphics of the program. The summary sheet is immediately followed by a direct reproduction of a complete lesson from that program. This gives you an opportunity to examine the organizational and graphic style of the material and also gives you an activity to try out with your classes to see how it reaches the students.

The second part of the **How** materials includes other curriculum guides, many of which contain useful exercises but were judged not to be as broadly useful as the Top. They may be dated or otherwise flawed, or they may be limited in their application. Besides such guides, this section contains a list of periodicals, audio-visual materials, computer software, field trips, and organizations that can help in the teaching of energy concepts.

Many of the materials included in this guide may be available free through the auspices of the utility company serving your school. Some utilities also have programs to help defray field trip costs to certain sites. The list of organizations in the second part includes the addresses and contact persons for most of the groups that provide such services.

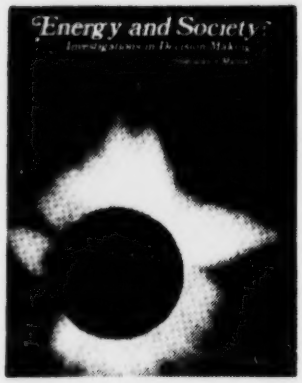
CURRICULUM MATERIALS MATRIX

This table is a summary of the curriculum materials reviewed in the **How** section of the resource book. The matrix is designed to help you locate materials suitable for a particular subject and of a particular length. For more information about the various units, consult the detailed review on the page listed. Materials are matched to the subject area in which the material is most likely to be used. However, this does not preclude the use of the activities in other courses.

EE MATERIAL	PAGE #	SUBJECTS																		LENGTH (TIME)				CONTENTS						TYPE		
		World Cultures	American History	Government	Problems in Modern Democracy	Economics	General Science	Biology	Chemistry	Physics	Earth Science	Drivers Education	Home Economics	Mathematics	Home Management	Industrial Arts	English	1-2 periods	1 week	2-5 weeks	More than 5 weeks	Simulations	Text/Readings	Computer Software	Student Worksheets/ workbooks	Teachers Guide	Photocopy Originals	Classroom Activities	Group Activities	Research Student Initiated	Community/ school based
Top materials																																
Energy and Society	31	•			•		•				•							•			•			•	•			•	•	•
Energy Choices and Challenges	35			•	•		•				•									•		•		•	•		•				
Energy, Food, and You	39	•			•		•	•					•		•			•							•		•	•			
IDEAS	43	•	•		•	•	•	•	•	•			•	•	•	•	•	•	•						•		•	•			
NEED PROJECT	47	•		•	•		•				•			•			•	•	•	•	•		•					•	•	•	
NY Energy Education Project	51			•	•		•	•		•	•	•					•	•	•					•	•	•	•	•	•	•	
People, Energy, and Appropriate Technology	57						•	•			•				•					•		•		•	•		•				
Politics of Energy	63			•	•															•	•	•	•					•				
Wind, Water, Fire, and Earth	67						•	•	•	•	•	•						•	•						•	•	•	•		•		
Other Materials																																
Economics of Energy	73					•	•											•						•	•	•	•				
Electricity	73				•		•				•								•	•		•			•		•				
Energy Activities for Home Economics	73											•		•				•	•						•		•	•			
Energy Activities for Industrial Arts	73											•						•	•	•					•		•				
Energy Activities for the Classroom	74	•	•		•		•					•		•				•	•						•		•				
Energy and Economics	74				•	•												•						•	•	•	•				
Energy Efficient Resource Guide for Drivers Education	74											•							•	•		•			•		•				
Energy, Environmental and Outdoor Education Activities	74							•						•				•	•						•		•				
Energy, Food, and Your Future	75				•			•												•		•			•		•				
Energy Reporter	75			•	•	•	•			•	•				•			•				•					•				
Enermomics	75					•								•						•		•		•	•		•	•			
Know Nukes	76			•	•		•	•	•	•	•								•	•		•			•		•		•	•	
Living Lightly on the Planet	76	•			•		•	•						•				•	•						•	•	•				
National Energy Foundation	76	•	•	•	•	•	•	•	•		•				•	•		•	•						•	•	•		•		
Playing with Energy	76	•		•	•	•	•	•			•					•		•	•		•				•	•	•		•		
Preparing for Tomorrow	77	•	•	•	•			•	•	•								•	•		•	•		•	•		•				
Renewable Energy: text	77				•									•	•			•	•			•					•				
Renewable Energy Activities for . . .	77						•	•	•	•	•	•						•	•					•		•	•	•				
Savings Through Energy Management	78						•				•			•		•					•	•			•				•	•	
Science Activities in Energy	78						•	•	•	•	•	•						•								•	•				
Teaching Energy Awareness	78	•			•							•			•	•		•								•	•	•	•		

TOP ENERGY
CURRICULUM MATERIALS

ENERGY AND SOCIETY



BIOLOGICAL SCIENCES CURRICULUM STUDY

1977, Public domain

SOURCE: Hubbard
P.O. Box 104
Northbrook, IL 60062

Grade Level: (9) (10) (11) (12)

Cost: 10 Student Books/$35.00
Teachers Manual $7.95

DESCRIPTION/CRITIQUE

This is a nine week instructional module designed to improve students' decision making abilities. The module provides opportunities for students to acquire accurate information about energy, to identify and analyze their own attitudes and those of others, and to consider questions and concerns about energy related issues. Students discuss basic information about energy, explore possible consequences of energy decisions, and select an energy-related research problem that they then investigate. The research includes consideration of the following categories: politics, economics, technology, attitudes, health and safety, environmental impact, and physical laws.

Use of this module may require the teacher to spend a considerable amount of time accumulating reference materials for the students to use in class. Although this is an old publication, which in the field of energy usually means it is out of date, it is still a valuable teaching aid because the emphasis is on conducting research and making decisions rather than energy data. This module is comprehensive in its approach to decision making and could be used in a variety of subjects because of its open ended nature.

MATERIALS

Student Activities	X
Teacher's Guide	X
Background Reading	
Spirit Masters	
Transparency Masters	
Equipment	
A-V	

SUBJECT EMPHASIS

Science	
Social Studies	
Home Economics	
Industrial Arts	
Interdisciplinary	X
Other	

APPROACH

Content Focus	
Process Focus	X
Content-Process Blend	
Discipline Focus	
Interdisciplinary	X
Multidisciplinary	
Infusion	

INSTRUCTIONAL STRATEGIES

Informational Text	
Stories	
Case Studies	X
Investigations	X
Games	
Simulations	
Group Discussion	X
Debates	
Demonstrations	
Questions	X

TIME FRAME

Single Class	
Multi-Class	
Units	X
Independent Study	X

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MAKING LOGICAL INTERPRETATIONS OF DATA

There is no question that you will want to and should interpret the data you collect. Interpretation is the attempt to generalize from information or to construct a general statement supported by the evidence. Study your data carefully to be sure that your interpretations are supported by data. Consider the following examples. What differences can you see between the poor interpretations and the better ones? What other valid interpretations can you suggest?

Data	Poor Interpretation	Better Interpretation
In a survey in Mapleville, 57% of the respondents said they would buy less gasoline if the price were higher.	Price hikes could solve the whole gasoline shortage problem in Mapleville.	Raising the price is one way of partially reducing gasoline consumption in Mapleville.
Industrial uses account for 41% of the energy consumption in the U. S.	Since industry uses so much energy, we should cut back on all manufacturing as soon as possible.	Since industry uses so much energy, we should begin immediate studies of the possibilities for energy conservation in industry.
Of 39 companies producing solar flat plate collectors in 1974, 7 were identifiable as companies, the other 32 as small businesses.	Large companies don't want to produce solar collectors.	In 1974, the market for solar collectors was dominated by small businesses, not large companies.
In 1949, 36% of the households used natural gas for heating. In 1971, the proportion had risen to 82%.	Before long, everyone will be using natural gas to heat homes.	If past trends were to continue, we might expect almost everyone to switch to natural gas for home heating.

GUIDE FOR ANALYZING REPORTS (GFAR)

Sometime during the data collection phase of your investigation, your instructor will ask you to use the GFAR given below to analyze the results of a sample investigation. From the discussion, you may be able to sharpen your skills in recognizing a poor interpretation, in differentiating facts from opinions, and in looking for ways to communicate information more precisely and effectively. But don't let your use of the GFAR stop with the discussion. Use it as you prepare the results of your own investigation; the GFAR will be a great help as you attempt to analyze your data and communicate your findings.

What Was Investigated?

Did the investigator explain exactly what questions he or she was trying to answer?

Did the investigator explain why he or she chose that particular question?

Did the investigator state any assumptions (things taken for granted or believed to be true) that were made in the investigation?

If not, were any assumptions made that should have been tested to see if they were really true?

How Was It Done?

Were the methods of data collection described clearly and in enough detail so that you can follow exactly what the investigator did?

Were these methods appropriate for the questions investigated? (For example, did the investigator interview people to get information that could have been observed directly or measured, like interviewing people to determine prices that could have been observed on a store's shelf?)

Were the sources of the data appropriate to the questions being investigated? (For example, did the investigator interview adults to find out what children thought about a particular problem?)

Was more than one source of data used, so that sets of data from different sources could be compared to verify the information? (If not, what other sources of data might have been used?)

If people's opinions were collected, did the investigator explain

- exactly what questions were asked, and when and where they were asked?
- whose opinions were collected?
- how many people's opinions were collected?
- how people were selected for participation in the survey?

Were unbiased questions asked? (Or did the investigator give away what kind of answer he or she wanted to get?)

Was a sufficiently large, random sample used? (Or did the investigator question only a few people who were pretty much alike?)

If observations and/or measurements were made, did the investigator explain

- exactly what was observed or measured?
- exactly how, when, and where observations or measurements were made?
- how many observations or measurements of the same kind were made at different times or in different places?

Were the measurements or observations repeated to make sure they were correct?

Were the measurements or observations made in an unbiased manner? (Or did the investigator seem to collect only those data that would support a particular position or point of view?)

If information from other sources was used, was it current, up to date?

Was it from a reliable, unbiased source? (Or was it from a source that might have special interest in supporting a particular position or point of view?)

What Was Found?

Was the information that was collected appropriate to the questions being investigated?

Were the information and data presented in a clear, brief manner?

When a lot of opinions, measurements, or observations were collected, did the investigator add together all similar results? (For example, "A total of 12 voters said they favored the proposed law and 28 were against it.")

Did the investigator report results as percentages? (For example, 56 percent agreed, 23 percent disagreed, and 21 percent had no opinion.)

Were tables, graphs, charts, maps, or pictures used to help communicate findings?

Could the data have been analyzed or presented in a better way?

Were enough data collected to answer the questions?

How Were the Data Interpreted?

Were conclusions, if any, supported by the data? (Or did the investigator draw conclusions based on insufficient or inappropriate data?)

Are other interpretations of the data possible? (Could the information collected be used to reach other conclusions?)

Did the investigator compare information from different sources and point out similarities and differences?

Were additional questions raised by the investigation?

Did the investigator suggest additional information that should have been collected?

Was the problem one for which solutions would be appropriate, and were possible solutions identified?

Did the investigator indicate why the findings might be important?

Did the findings suggest any solutions to a problem? If so, were alternative solutions discussed?

SAMPLE REPORT

The sample report is given below along with indications of points where you will stop for discussion. Your instructor will show you how to use the GFAR as a basis for analyzing this sample report.

To the Editor
Gasville Daily Post

I am writing because of the recent gasoline shortages in Gasville and because of the energy crisis everyone is talking so much about. I think increasing the miles per gallon that cars get could make a big difference. I've studied the subject and I think there's a lot that can be done.

STOP FOR DISCUSSION

One place where I think gas mileage can be improved a lot is by driving smaller cars. I wanted to check this out, so I counted and classified all the cars coming into the Succulent Steak and Lobster House parking lot between 7 and 9 p.m. last Friday evening. During that time, 220 cars came in. There were 132 full-sized cars, 40 mid-sized cars, 24 compacts, and 4 sub-compacts. So almost 70% of the cars were big. This shows that most people in Gasville drive big cars.

STOP FOR DISCUSSION

Based on this information, I decided to do a phone survey to find out more about what the attitudes of people are on driving smaller cars. I picked 40 names of people out of the phone book, and gave them the survey questions over the phone. I called in the evening from home. Some of the people I tried were not home, so I picked new people. This chart shows the survey questions and the results that I got.

Phone Survey

1.	How many cars does your family own?	none 3	one 23	two 10	three 3	more than three 1
2.	What kind of car does your family drive most often?	sub-compact 7	compact 15	mid-sized 9	full-sized 6	
3.	For what major purpose do you use your car(s)?	to go to work 24	shopping 8	short recreational trips (eating out, visiting friends, movies, etc.) 3	vacations and long business trips 1	other 1
4.	How much do you spend for gasoline in an average week?	0-$2 0	$2-$5 8	$5-$8 18	$8-$10 9	more than $10 2
5.	If gas cost twice as much, would you drive a smaller car?	Yes 17	No 13	Maybe 7		
6.	Since driving big cars is the major cause of the gasoline shortage, are you willing to drive a smaller car?	Yes 31	No 4	Maybe 2		
7.	How would you rate the gas shortage in this community?	severe 7	moderate 24	none 6		
8.	In your opinion, what part do big cars contribute to the gas shortage?	a major contributor 25	contribute some 8	not a noticeable amount 6		

STOP FOR DISCUSSION

I got some additional information about the weight of cars from a newsletter published by the Federal Energy Administration. The Environmental Protection Agency says that if we reduce the average weight of our cars from the present 3,500 pounds to 2,500 pounds, this country would save 2.1 million barrels of oil a day—about a third of our present vehicle fuel consumption. And the average car owner who drives 10,000 miles a year would save around 100 gallons a year—so there would be a money saving, too. Given the answers I got on Questions 6 and 8 of my survey, I think people in Gasville will soon be driving lighter-weight cars and saving gas and money at the same time.

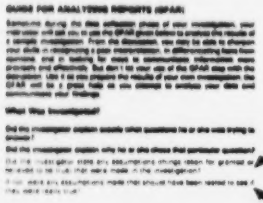
STOP FOR DISCUSSION

The EPA also suggested that lighter cars could have smaller engines and still perform just as well. I wanted to check to see if smaller engines get better gas mileage, so I selected some data from the EPA book

To the Editor
Gasville Daily Post

I am writing because of the recent gasoline shortages in Gasville and because of the energy crisis everyone is talking so much about. I think increasing the miles per gallon that cars get could make a big difference. I've studied the subject and I think there's a lot that can be done.

STOP FOR DISCUSSION

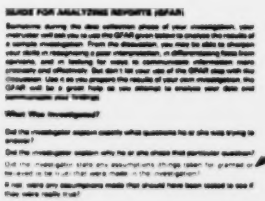


Two assumptions are made; the first one is quite obvious: "I think increasing the miles per gallon that cars get could make a big difference." The second is implied and may be more difficult for students to identify: "I think there's a lot that can be done."

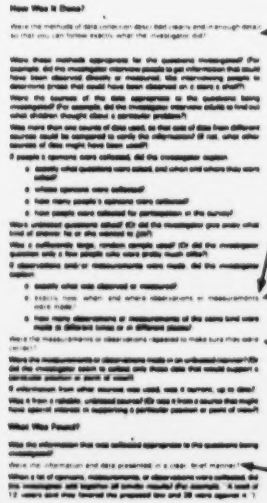
Students may suggest that the basic assumption, "increasing the miles per gallon that cars get could make a big difference," should be backed up with data (e.g., increasing gas mileage by 25 percent would save us more than one million barrels of oil a day—about six percent of our total oil usage). The introduction above would have been stronger if the investigator had included statements such as, "This is an important problem. Transportation accounts for 25 percent of our nation's energy use, and over half that amount is consumed by automobiles."

One place where I think gas mileage can be improved a lot is by driving smaller cars. I wanted to check this out, so I counted and classified all the cars coming into the Succulent Steak and Lobster House parking lot between 7 and 9 p.m. last Friday evening. During that time, 220 cars came in. There were 152 full-sized cars, 40 mid-sized cars, 24 compacts, and 4 sub-compacts. So almost 70% of the cars were big. This shows that most people in Gasville drive big cars.

STOP FOR DISCUSSION



The assumption that smaller cars get better gas mileage should have been validated. Existing data from a variety of readily accessible sources—such as EPA, FEA, and the Motor Vehicle Manufacturers Association—support the assumption.



During the discussion the question, "Did the investigator really sit there for two hours and count cars?" may come up. Explain that the investigator actually counted cars for *only 30 minutes*. The results were then multiplied by four to get the total for two hours. The actual counts were 38 full-sized cars, 10 mid-sized cars, 6 compacts, and 1 subcompact. Discuss whether the data are valid—you might ask how the validity (or accuracy) of this sampling method could be checked. You may also want to emphasize that, regardless of its validity, the investigator should have accurately reported how the data were obtained.

The investigator assumed that people going to the Succulent Steak and Lobster House were a representative, random sample of the entire community.

Since no attempt was made to cross-check and confirm the data, ask the students to suggest ways of verifying the data that were collected.

Students should observe that data are much easier to remember and compare when recorded on some kind of table or chart.

Ask if the investigator drew any conclusions from the data. The conclusion "most people in Gasville drive big cars" is unjustified. Unless the community is very homogeneous in income and life-style, people eating out at a steak house could hardly be expected to represent a random, unbiased sample. Furthermore, the investigator has sampled "recreational" use without any data to suggest that people use cars primarily for that purpose. Ask students what better techniques the investigator might have used for gathering the data.

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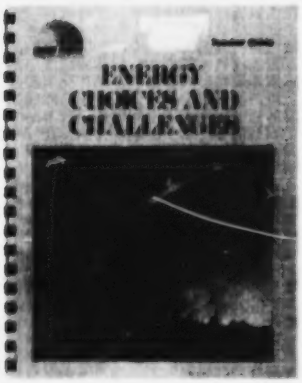
ENERGY CHOICES AND CHALLENGES



ENERGY SOURCE ENERGY EDUCATION PROGRAM

1984, Copyright

SOURCE: Energy Source Council
5505 E. Carson, Suite 250
Lakewood, CA 90713

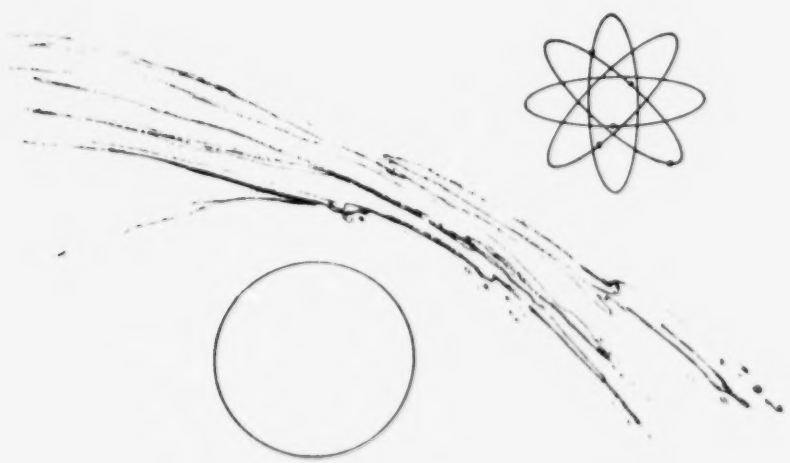
Grade Level: (9) (10) (11) (12)

Cost: $25.00/teacher book
$75.00/35 student books

DESCRIPTION/CRITIQUE

This is a comprehensive kit of materials dealing with the sources and uses of energy. The final section introduces several unresolved energy topics, e.g. leasing offshore lands, radioactive waste disposal, and energy independence. The student booklet contains readings, drawings, discussion questions, and further references. The kit is supplemented with a teacher's guide containing additional activities as well as a poster and two filmstrips.

Some of the energy data are out-of-date but this is more a reflection of the dynamic state of energy supply than an educational drawback because it reinforces the need for students to be aware of ongoing energy-related developments. Best use of this material would be in class studying energy and used as a starting point for other activities or student research.



MATERIALS

Student Activities	___
Teacher's Guide	X
Background Reading	X
Spirit Masters	___
Transparency Masters	___
Equipment	___
A-V	X

SUBJECT EMPHASIS

Science	___
Social Studies	X
Home Economics	___
Industrial Arts	___
Interdisciplinary	X
Other	___

APPROACH

Content Focus	X
Process Focus	___
Content-Process Blend	___
Discipline Focus	___
Interdisciplinary	___
Multidisciplinary	___
Infusion	___

INSTRUCTIONAL STRATEGIES

Informational Text	X
Stories	___
Case Studies	___
Investigations	___
Games	___
Simulations	___
Group Discussion	X
Debates	___
Demonstrations	X
Questions	X

TIME FRAME

Single Class	___
Multi-Class	___
Units	X
Independent Study	___

SOURCES ON THE HORIZON

Perhaps the most striking feature of the energy sources that can help meet our future needs is their variety. At one extreme is one of man's oldest sources of energy, wind power. At the other is nuclear fusion, an advanced space-age process that poses tremendous technological challenges but could yield an enormous amount of energy.

Wind power, geothermal energy, and biomass are already providing small amounts of power today. In each case, there are only certain geographical areas where the source exists in sufficient quantities to be usable. However, they could all become important in the locations where they are readily available.

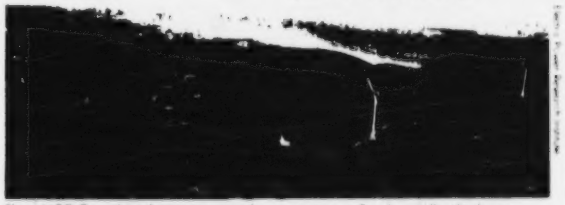
Two other sources, oil shale and synthetic fuels, are not yet part of our power supply but may one day provide energy in much-needed forms. Oil shale yields a liquid fuel similar to crude oil, and synthetic fuels can be manufactured from coal in forms similar to both oil and natural gas. However, oil shale and synthetic fuels are much more expensive to produce at this time than our conventional fuels. Their entry into the market will depend on their ability to compete in cost with other sources.

One thing is certain about these sources: none of them will become an energy powerhouse overnight. It takes decades to make a new source practical for general use, both from a technological and a cost standpoint. That's why advance planning and ongoing research and development activities are so important. It also helps to explain why the sources described here are unlikely to make their most significant contributions until after the year 2000.

Wind Power

For centuries, man has used the wind to move ships and to power windmills that grind grain and pump water. In the early 1900's, windmills were widely used on individual farms and ranches to pump water and to power small generators that provided electricity. As centrally generated electricity from large power plants was extended to rural areas between 1930 and 1950, most windmills disappeared. Today wind power is making a comeback in some locations. Higher energy prices and the need for new resources have created renewed interest in it.

The blade of NASA's MOD-2 wind machine has a span of 300 feet and is mounted on a cylindrical tower 200 feet high.



Three MOD-2 wind machines are presently in operation at Goodnoe Hills, Washington. These machines begin to generate electricity when the wind reaches 14 mph. They shut down automatically in winds over 45 mph to avoid structural damage.

Harnessing the energy in wind requires a wind machine. For large-scale wind systems, two different designs are receiving the most attention. One looks like a huge airplane propeller, the other like a giant eggbeater. The most advanced design of the large propeller-type machines has a rotary blade that is 300 feet long, the length of a football field. Wind spinning the blades of these machines can be used to run generators that produce electricity. The electricity can be used by a utility company's operating electrical system. Of course, other groups or individuals can also install their own smaller systems where wind conditions are favorable.

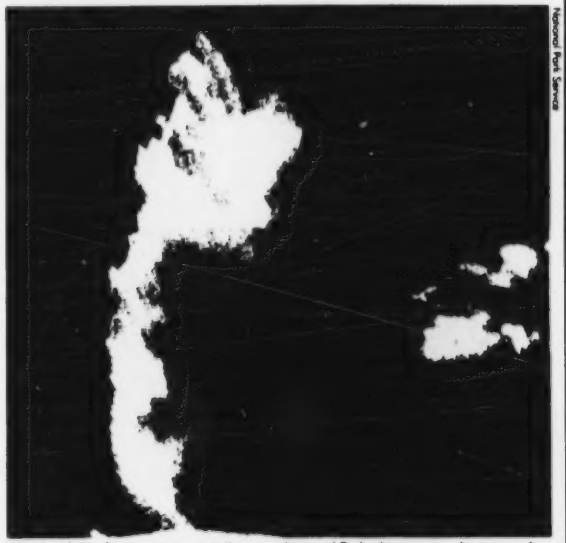
Like other energy sources, wind power has its own special requirements and drawbacks. Large-scale use is feasible only in areas where the wind blows consistently enough and hard enough — about 15 miles per hour or more — to turn the huge blades of wind machines. Even then, a considerable land area supporting many machines is needed for the production of large amounts of electricity. However, in suitable locations the same land also could conceivably be used for another purpose, such as farming. A further problem is the intermittent nature of wind. A backup power system must be available when the wind isn't blowing hard enough.

The technology for large-scale production of wind power is still in the development stage. In recent years there has been a rapid increase in the number of wind projects in this country, and some test projects are now generating small amounts of usable electricity. Advanced designs to be constructed and tested over the next several years will help to indicate wind power's future potential.

Geothermal Energy

Geothermal energy comes from heat generated by natural radioactivity beneath the earth's crust. Molten rock, called magma, heats the layers of hard rock and the underground water above it. This heat remains miles underground in most parts of the earth and is not economical as a source of energy because of its depth. In some areas, however, the heat escapes to the surface in the form of volcanoes, geysers, hot water, or ground openings that continuously release steam. These hot spots indicate that geothermal energy is close to the surface.

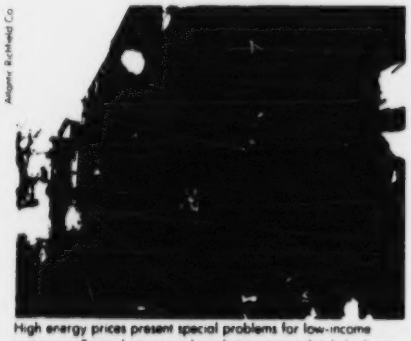
The primary use of geothermal energy is in the production of electricity. Both steam and hot water from underground can be used as energy sources. The most common method for reaching steam is to drill a well to it. Pressure forces the steam to the surface where it is channeled directly to turn turbines that generate electricity. Hot water resources are receiving increased attention because they are more common than usable steam. Hot water is drawn from its natural underground reservoir and its pressure is dropped, causing some of it to vaporize into steam. The steam is then channeled to turn a turbine-generator. Geothermal steam or hot water can also be piped into buildings to heat them directly without being converted to electricity. It is used in this manner in Iceland particularly, and even in a few locations in the United States and several other countries.



National Park Service

"Old Faithful," a famous geyser in Yellowstone National Park, demonstrates the power of heat that exists below the earth's surface.

Energy for the Needy



Atlantic Richfield Co.

High energy prices present special problems for low-income customers. Several programs have been proposed to help these people, many of them elderly, with their utility bills.

If you live in this country, do you automatically have the right to be warm when it's freezing outside?

As energy costs rise, Americans are having to face this question more and more. For example, the Citizen-Labor Energy Coalition, a consumer group, estimated that 240,000 housholds had their natural gas cut off during a recent winter because of unpaid bills. And this estimate covered only natural gas, not households heated with fuel oil or electricity.

Rising energy costs are a special problem for the elderly. Northern States Power Company (NSP), a utility based in chilly Minnesota, reports that nearly one in every three of its customers over age 60 is low-income. The elderly comprise 60 percent of NSP's low-income customers. Commenting on the national situation, Richard Chamberlain of the Salvation Army says, "It's not so much paying the bills — shut-off notices are few — but the elderly are going without nutrition to pay their utility bills."[1] Another group that has been hard hit are the "new needy" — people who have suddenly lost their jobs and cannot find work because of tight economic conditions.

To deal with the problem, utility companies are committing millions of dollars of their own money and soliciting additional help from the public. Around the country a growing number of programs are springing up. A few examples:

Many utilities remind customers on their monthly bills that they can voluntarily pay extra, with the added dollars going for the needy.

In addition to their other assistance programs, several utilities contribute a dollar or two for each dollar donated by their customers.

A northern utility has proposed a plan to its state public utilities commission that would give a 25 percent discount to its low-income ratepayers. The utility estimates that this program would cost its other ratepayers less than $5 a year. The same company will not cut off a low-income customer's gas or power during the cold-weather period of October 15 to April 15 if the customer works out an approved payment schedule for overdue utility bills.

A midwestern utility sells $5 to $100 "I Care" gift certificates that can be given to the needy.[2]

The federal government is helping too. Its federal energy assistance program returns nearly $2 billion in energy grants to the states. Traditionally these funds have been used mainly to help the needy pay heating bills. Now energy officials in some states are using part of the money to help low-income families make improvements that upgrade the energy efficiency of their homes.

Still, all these funds are not nearly adequate to solve the problem. Under many programs the available money is only enough to provide a fixed amount of help, such as $100 to $200 for the entire winter season. Heating bills for a single winter month often run much higher than that in colder areas of the country.

"This is a problem that won't go away by itself," emphasizes Richard Stanford of Northern States Power. "We've got to deal with it in a better way than we are now."

Discussion Questions

1. What do you think should be done so that low-income Americans get the energy they need? Select an answer from the choices below or come up with your own.

   a. The federal government should use tax money to pay for it.

   b. Utilities should request rate increases from their public utilities commissions and use the extra money to pay the utility bills of their low-income customers.

   c. We should do what we can on a voluntary basis but not require anyone to pay extra just for the benefit of others.

   d. Nothing. Low-income people should deal with the problem themselves.

   e. Other. (Give an answer of your own that you think is better than any of the above.)

2. Suppose that you were in charge of a state program to provide energy assistance to the needy. For which purpose would you spend more money: payments to help low-income persons pay their energy bills or payments to help them make their homes more energy efficient? Why?

Notes

[1]Bill Curry, "Utilities, Customers Chip In to Help Needy Pay for Heat," *Los Angeles Times*, 30 Jan. 1983, Sec. 1, pp. 1 ff., col. 5.

[2]Curry, p. 8.

Lesson 5: Sources On The Horizon
Issue: "Energy For The Needy"

Materials: ECC books

- **Go over the answers to the review questions for "Sources on the Horizon."** Use the same procedures as for the previous review questions. Be sure to collect the papers after the in-class review and return them later after you have had a chance to make sure that students answered the questions.

Review Questions and Answers

1. Which source described in this section is made from coal?

   Synfuels

2. Which source poses great technological challenges but could fill a large part of our need for electricity if the problems are overcome?

   Nuclear fusion

3. Which source was used in the early 1900's and is making a comeback today?

   Wind

   Biomass could also be considered a correct answer, since Americans burned a lot of wood in the early 1900's and recently began to burn more again as energy prices rose.

4. Where is most of the geothermal energy in the United States produced?

   The Geysers, a large plant in Northern California that uses underground steam.

5. Which source from this section is an important one for the forest industry?

   Biomass

6. What do wind power, geothermal energy, and biomass have in common with regard to where they can be used?

   Each exists in usable amounts only in certain geographic areas.

7. There is more oil in U.S. deposits of this source than in the known reserves of crude oil in Saudi Arabia. Which source is it?

   Oil shale

8. What is the main reason that the United States isn't producing oil shale today?

   Cost

   Environmental factors are also a problem, but cost is the main reason.

- **Assign the "Energy for the Needy" issue.** If you did not assign this issue as homework, have the students read it in class.

- **Hold the class discussion of "Energy for the Needy."** Have students answer the questions for this issue and discuss their answers in class. Rather than calling on individual students for their answers to the first question, you may want to take a count of the number selecting each answer so that you can record and discuss the class preference. The questions are given below.

1. What do you think should be done so that needy Americans get the energy they need? Select an answer from the choices below or come up with your own.

   a. The federal government should use tax money to pay for it.

   b. Utilities should request rate increases from their public utilities commissions and use the extra money to pay the utility bills of their low-income customers.

   c. We should do what we can on a voluntary basis but not require anyone to pay extra just for the benefit of others.

   d. Nothing. Low-income people should deal with the problem themselves.

   e. Other. (Give an answer of your own that you think is better than any of the above.)

2. Suppose that you were in charge of a state program to provide energy assistance to the needy. For which purpose would you spend more money: payments to help low-income persons pay their energy bills or payments to help them make their homes more energy efficient? Why?

   Answers will vary, but they should take into account the immediate need for money to pay energy bills versus the long-term benfits of lower energy bills for the individual and less overall energy use.

- **Assign the reading and review questions for Lesson 6.** Assign reading of "The Electric Connection" (pages 43-45) and writing of answers to the review questions as homework or an in-class activity. "The Electric Connection" is very short. You may want to assign reading of the issue for Lesson 6, "Hot Debate Over Acid Rain," along with it.

- **Additional Activities**

  Have students vote by ballot on the discussion question for this issue, but with choice e eliminated. Then assign those who voted for each choice to present the case for the choice they selected.

  Have students research the number and characteristics of low-income areas in your area. They can collect and report information such as the following from local or state social service agencies and from utilities.

  What income level qualifies a person or family as low-income?

  What percentage of the households in your state or local area are low-income?

  What age groups are represented and in what percentages?

  What cost assistance programs are available to them by federal and state governments? By utilities?

  How many natural gas and electricity shutoffs occurred last winter? What percent of all customers were affected?

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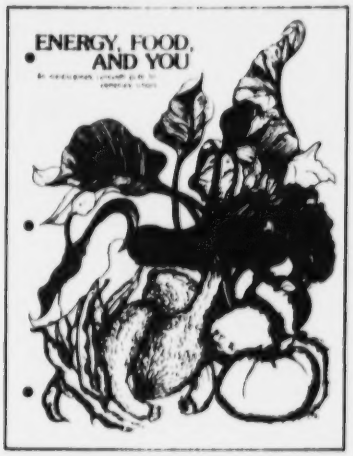
ENERGY, FOOD, AND YOU



WASHINGTON STATE OFFICE OF PUBLIC INFORMATION

1979 rev., No Copyright

SOURCE: Energy Food and You Program
ESD–189
205 Stewart Road
Mount Vernon, WA 98273

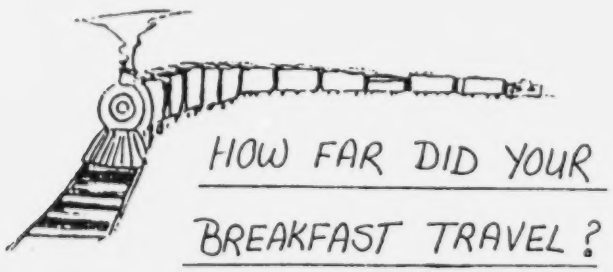
Grade Level: (9) (10) (11) (12) **Cost:** $6.00/ per volume

DESCRIPTION/CRITIQUE

These two large guides for Grades K-6, 7-12 are an excellent source of information and activities on factors dealing directly or indirectly with food production and related energy topics. Included are the non-renewable sources of energy used in food production and distribution, "hidden" energy requirements of the food system, the environmental impact of food habits, nutrition, the need for more efficient fossil fuel use, and the need for more reliance on renewable source. Each guide is divided into three sections, Global Food and Resource Needs, Energy and the U.S. Food Systems, and Energy Efficient Nutrition.

The activities are arranged by concept and cross-indexed by subject. The lessons and other ideas for creative teaching can be infused into an existing course of study, taught as a unit for the appropriate level and discipline and/or used for independent study. The format for each activity includes the concept and subconcept addressed, discipline, grade level, objectives, materials required, procedures, bibliography and resources. Some even include comments.

A few lessons are oriented to the Northwest and/or the State of Washington, but, are easily adapted. A few references may be dated.



MATERIALS

Student Activities	X
Teachers Guide	X
Background Reading	X
Spirit Masters	X
Transparency Masters	
Equipment	
A/V	

SUBJECT EMPHASIS

Science	
Social Studies	
Home Economics	
Industrial Arts	
Interdisciplinary	X
Other	

APPROACH

Content Focus	
Process Focus	
Content/Process Blend	X
Discipline Focus	
Interdisciplinary	
Multidisciplinary	X
Infusion	X

INSTRUCTIONAL STRATEGIES

Informational Text	X
Stories	X
Case Studies	X
Investigations	X
Games	X
Simulations	
Group Discussion	X
Debates	
Demonstrations	X
Questions	X

TIME FRAME

Single Class	X
Multi Class	X
Units	
Independent Study	X

ACTIVITY TITLE: Why Do I Buy It?

CONCEPT: Patterns of food consumption in the U.S. are influenced by advertising, consideration of status, convenience, and ethnic background; most of which are unrelated to nutrition.

SUBJECT AREA: Home Economics, Communication

GRADE LEVEL: 10-12

OBJECTIVE: To find out the reasons people in a grocery store buy certain food products.

To list which factors are most influential in getting people to buy certain food products.

ACTIVITY:

1. Develop a questionnaire in class to interview people in a grocery store about the reasons they buy the items in their grocery cart. Some considerations: Which of these factors entered into your decision to buy this product?
   a. The cost per pound.
   b. The convenience in preparation.
   c. TV advertising influences.
   d. High nutritional value.
   e. Lack of artificial coloring, flavoring, or preservatives.
   f. Your mother used it.
   g. Buying this because you are having company.
   h. Trying something new.
   i. Catchy packaging--visually attractive.
   j. A friend recommended it.
   k. Thought it was on sale.
   l. Buying it for the kids.

2. Try to poll about 10-15 shoppers and ask each about five items in his/her cart.

3. Chart the results of your interviews. Sample

Food Product	Cost	Convenience	Advertising	Nutrition	No artificial	Mother	Company	New	Packaging	Friend	Sale	Kids

4. Count the number of TV ads and the techniques (appeals) used to promote food over a specified period of time.

TEACHER COMMENTS: Consumer Economics - I devoted one week to discussing food buying and advertising. Then I gave each student five charts for their interviews. We walked to the store and started interviewing. Some students just handed the questionnaire to the one interviewed, some went so far as to ask the interviewee the questions aloud. Of 90 people interviewed, 25 answered "nutritional reasons"; 32 "cost"; 23 "convenience"; 4 "because their kids wanted it"; 1 because "no artificial ingredients"; 5 "because they were on sale"; 1 "because it was new." Back in class, students made a graph to show why consumers buy food.

5. Analyze the results of your interviews and viewing. Which was the most common reason for buying a food product? What percent of the time was nutrition one of the reasons?

BIBLIOGRAPHY & RESOURCES:

C. Arthur, "Checking Out Supermarkets," Nutrition Action.
R. Choate, "The Sugar Coated Children's Hour," The Nation.
R. Choate, Chairman, Council on Children, Media and Merchandising, "Report to the Federal Trade Commission."
C. Lerza and M. Jacobson, Food for People, Not for Profit.
V. Packard, The Hidden Persuaders.
C. Shoemaker, "Influencing Supermarket Policies," Nutrition Action.
Slide/tape show, "Trash Tells A Tale".
Contact the consumer action group: Action for Children's Television, 46 Austin Street, Newtonville, Mass. 02160.

TEACHER COMMENTS: Home Economics: Excellent, we would do this as an individual project. Classrooms of students would overrun the market, but it would be a valuable experience. A variation might be to interview their own families to find out why foods have been purchased for home use.

ACTIVITY TITLE: Passenger List for Spaceship Earth

CONCEPT: Seeing the world as a spaceship is an effective way to raise questions about our relationship and responsibility to our ship and its other passengers.

SUBJECT AREA: Social Studies, Contemporary Problems

GRADE LEVEL: 10-12

OBJECTIVE:
1) To raise questions about what sustains life on earth.
2) To raise questions about international relations and responsibility.

OCCUPANCY LOAD: 4.6 Billion

CARRYING CAPACITY: ?

LOCATION OF OCCUPANTS:

1st Class
North America
Western Europe
1st World

2nd Class
Eastern European
2nd World

Tourist Class
Third World Nations

Baggage Area
Fourth World Nations

Wheel Wells
Fifth World Nations

ACTIVITY:
1. List the basic necessities for the well-being of all the passengers on spaceship earth.
2. List the amounts of supplies carried by spaceship earth. If you cannot list the amounts, explain why.
3. Do all passengers have the basic necessities? If not, why?
4. In order to maintain our 1st and 2nd class cabins, what products do we receive from the other passengers on spaceship earth.
5. What responsibilities do the occupants of planet earth have to each other and to spaceship earth?
6. Given the statistic that "by the year 2000 90% of the population of spaceship earth will be made up of members of the 3rd, 4th and 5th World," what conclusions can be drawn concerning our relationship to these people?

ACTIVITY TITLE: "Fresh" Tomatoes in March?

CONCEPT: High energy inputs in the food system are caused by the demand for out of season crops. The tradeoffs include: wide variety of foods vs. energy resources used; increasing centralization of distribution systems vs. decreasing small, local farms.

SUBJECT AREA: Home Economics

GRADE LEVEL: 7-12

OBJECTIVE:
1) To list the foods they eat and note the months those foods are naturally available in their locality.
2) To document availability of out of season foods and consider what types of resources have been employed to provide them out of season.

ACTIVITY:
1. Have students list fresh fruits and vegetables that they like to eat.
2. Have students determine the growing season of these crops by consulting garden books and by contacting produce companies, farmers, and agribusiness companies.
3. Fill in chart below:

Crop	Months Available from NW Farms	Months Available from US Farms	Months Available in Markets	Energy Used To Keep Food Available Out of Season

4. Have students determine what seasonal foods they could grow in a school garden, and at home.
5. After students have determined amounts and types of energy used to keep foods "fresh", have them suggest energy-saving alternative uses for that same amount of energy.

BIBLIOGRAPHY & RESOURCES:

National Science Teachers Assoc. (NSTA), Energy-Environment Source Book.
Farmers Alamanac
Sunset Western Garden Book.
USDA, Conserving the Nutritive Value in Foods.
M. Krupp and M. Chatton, Current Medical Diagnosis and Treatment 1977.

TEACHER COMMENTS: We could not compute the energy used to keep food available out of season. 7th grade students felt we should eat northwest products, not California tomatoes and lettuce. It surprised them to find the local fruit stand sold only Cal. products!

Energy and Language Arts

TEACHER COMMENTS: Language Arts -- Some general ideas about the secondary energy curriculum in relation to Language Arts:

It seems to me that Language Arts can work explicitly with energy issues when class focus is either on:

I literature or
II communications, group process, values

Language Arts assignments in grammar, writing, drama can supplement explicit energy work in other courses.

I. Bibliography

The following books, chosen from lists of "Classics" and "Most Frequently Reads" are grouped according to the energy themes they might elucidate.

1. Critiques of blind progress

Chronicle for Leibowitz - Science Fiction, chronicling the progress of technology from monastery to nuclear war, twice. Horrible. Moral: Man doesn't learn from his mistakes.

A Connecticut Yankee in King Arthur's Court, Twain - fantasy, showing how a well-intentioned clever Yank can technologize the Medieval world of King Arthur, improve it, to the point that he destroys both the humanity, himself, and his technology. Question: What good is progress, afterall?

Grapes of Wrath, Steinbeck - In between the history of a family during the depression are chapters detailing and protesting agribusiness' takeover of small farming, overuse and destruction of soil, and tractor-armored loss of feeling for the land -- all in the name of impersonal Bank's Profit. Chapters from this book could be excerpted for single "energy" lessons.

Enemy of the People - Ibsen - Driving, simple-pointed play about a doctor who exposes an upstream tannery's pollution of his town's sulpher baths. He expects praise for his enlightened morality, but gets kicked out of his job, house, status. Theme: the majority acts like a blind and mindless herd for short-term self-interest.

Heart of Darkness - Conrad - The main theme is existential and difficult; but a secondary theme is socio-political: He attacks white colonialism in Africa, exposing the cruelty and egotism of "manifest destiny," showing how such insensitive exploitation may be self-destructive.

Tradition and Change in Tribal Africa, others of Colin Turnbull's books; Benito Cereno - Melville; The Ugly American - Lederer and Burdick; Cry the Beloved Country and Too Late the Phalarope - Paton, all protest white English-speaking exploitation of Third World people. Hence they justify discussions regarding U.S. exploitation of the Third World.

Flowers for Algernon - Keyes, widely read. It raises the progress question around the basic metaphor of apple-eating.

2. Nature vs. Humankind

There are many books, and increasing, about people who live "natural" lives. Any of these which encourage walking through land as a fish swims through water, leaving no trace, can be background for discussions on exploitation, balance, pollution... Eiseley, Pilgrim at Tinker Creek, Willa Cather, Oliver deFarge, The Yearling, Giants in the Earth ...

Thomas Hardy and Robinson Jeffers are "nature fatalists" who repeatedly argue that nature cool and passionless will ultimately overcome man - the theme of Ozymandias. Satirically they encourage ceasing to exploit, beginning to revere mother nature.

2001, Michener's Source, ch. 1, Golding's Inheritors, and Lord of the Flies show cavemen or primitives living pretechnologically. I would use these to propose that living less technologically, i.e. conserving, can be fun! And to base a lesson on how hard people used to have to work to survive - so are we behaving responsibly with the leisure time our energy use buys us? Also Huckleberry Finn, Robinson Crusoe, Swiss Family Robinson.

II. Group Process, Values Clarification Skills

1. Lifeboat - simulates a world where energy is scarce. How do priorities change?

2. Advertising analysis - from one lesson to a whole unit on the values and politics and psychology of consuming and persuading. If we're that manipulable, can we be manipulated towards healthier, more energy-efficient consuming or conserving?

3. Summit Conference Games - little U.N. conferences on international energy issues - population, pollution, distribution of food and energy, private ownership and individual rights vs. public ownership and regulation... Information is provided so that the exercise teaches communications rather than research skills.

IOWA DEVELOPED ENERGY ACTIVITY SAMPLER

IOWA DEPARTMENT OF PUBLIC INSTRUCTION/ IOWA ENERGY POLICY COUNCIL

1980 Rev., No Copyright

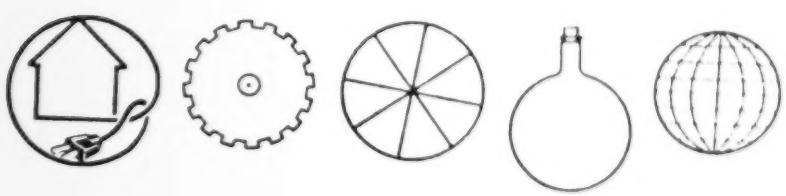
SOURCE: Iowa Department of Public Instruction Information & Publications
Grimes State Office Building
Des Moines, Iowa 50319

Grade Level: (9) (10) (11) (12)

Cost: $36.00 set
$ 6.00 individual volume

DESCRIPTION/CRITIQUE

These are six guides that suggest energy related activities for a specific discipline: math, science, social studies, language arts, home economics, and industrial arts. Each instructor guide is divided into 4 parts: introduction to energy education including general objectives for both teacher and student; list of activities; teacher information includes background information, glossary and bibliography; student activities. Each guide includes a key to subject and grade level as well as type of activity: background information, teacher directed, or student centered. The topics covered are energy use, physical properties, lifestyle and conservation. There are many value-choice type activities. Assumed energy background varies with activity. Some activities are presented in detail and others briefly. Although each guide has a discipline focus, many of the activities are multi-disciplinary. These activities can best be used by incorporating them into existing courses of study. Well planned, worth having.



MATERIALS

Student Activities	X
Teachers Guide	X
Background Reading	
Spirit Masters	X
Transparency Masters	
Equipment	
A-V	

SUBJECT EMPHASIS

Science	X
Social Studies	X
Home Economics	X
Industrial Arts	X
Interdisciplinary	
Other (lg. arts-math)	X

APPROACH

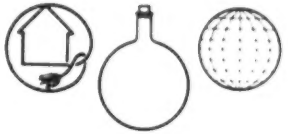
Content Focus	
Process Focus	
Content-Process Blend	X
Discipline Focus	X
Interdisciplinary	
Multidisciplinary	
Infusion	X

INSTRUCTIONAL STRATEGIES

Informational Text	X
Stories	X
Case Studies	X
Investigations	X
Games	X
Simulations	X
Group Discussion	X
Debates	X
Demonstrations	X
Questions	X

TIME FRAME

Single Class	X
Multi Class	
Units	
Independent Study	



Trends and Consequences:
The Futures Wheel

Background:

The energy transition is making us aware that energy is a potent social and economic force. Some of the effects of shortages of fuel, such as inflation and unemployment, hint of lifestyles in the future that may be different from those to which we are accustomed. We want to know not only about the choices available to us, but also what the consequences of various alternatives may mean to us, to our society, and to the world community in the future.

Activity:

A futures wheel is a tool to help students examine possibilities and consequences of following trends or using innovations. It is a graphic way to emphasize complex interrelationships.

Materials:

Magic markers and newsprint or butcher paper; or
large chalkboard and chalk

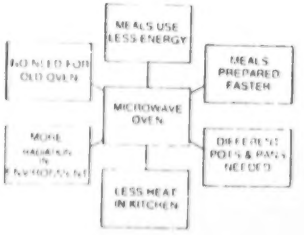
Directions:

Near the center of the paper or the chalkboard, write the name of an energy innovation or trend (a gasoline tax increase of $.50/gallon; farmers refuse construction of high voltage lines over their property; sales of wood burning stoves are up 500%; solar heating systems are mass-produced; thermostats in all schools are kept at 65°; only Australia has uranium left; fusion succeeds; electric cars are widely used; sun rights of individual property owners are protected by law; etc.).

Draw a circle or a box around the item chosen. Then ask the class, "What are the probable consequences of this innovation or trend?"

Write each of the effects outside and around the circled energy innovation or trend and draw circles or boxes around each of them. Draw lines connecting them to the original. An example for "microwave oven" is shown. The initial reactions are called first order consequences. They are indicated by the single lines connecting the energy innovation with its possible consequences.

Diagrams from Joel Barker,
Director, Future Studies Dept.
Science Museum of Minnesota,
St. Paul, Minnesota 55101
Used with permission.



Now ask the question--"what are the possible effects of this consequence?" for each of the first order consequences. Draw in and connect each secondary effect proposed by students with two lines between it and the first order to which it relates. Continue this process for about four orders of consequences, using three lines for connecting third order ones and four lines for the fourth order.

It's usually wise to limit the futures wheel to no more than four orders in classroom use. Not only do possibilities get more remote, but also there are visual, spatial, and conceptual limits to be respected. (However, some students may be intrigued enough to enjoy the challenge of a futures wheel assignment to be done outside of class with a less limited time constraint.)

A futures wheel developed for the microwave oven is included for an example of a way to show multiple consequences. The number of connecting lines between boxes indicates the order of each effect.

Remember that the assumptions learners make are not right or wrong and do not have to be highly probable. They represent possibilities only and should be recognized as such.

Now that you have shown students how to draw a futures wheel, ask each to make one individually or with a small group (4 to 6 are recommended for brainstorming), using a different energy-related innovation or energy trend. On completion, hang the wheels on the walls and have students share them with the class.

As a follow-up activity, have students categorize the nature of the various consequences. Are they social, economic, technological, environmental, or related to world politics for example. (First let students suggest all the

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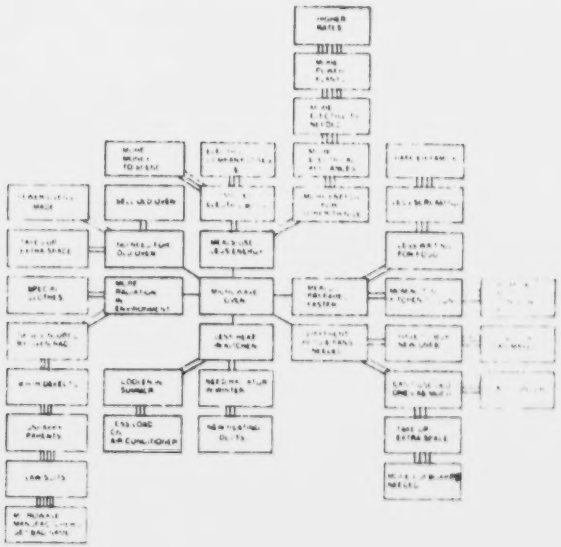
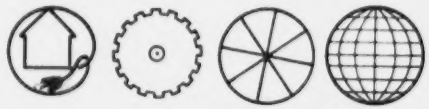
categories they can recognize. Then combine or elaborate on them as necessary.) Then tally the responses by category. What kinds of effects were easiest (most often mentioned) to foresee?



Reference: J. A. Barker, "Futures Study in Curriculum Planning," pp. 56-61 in The Role of Future Studies in Public Education. Misc. Publ. of the Science Museum of Minnesota, No. 4. St. Paul, MN, 55101.



Energy in Manufacturing--II

Nearly all common materials require some processing before they are ready for use in standard form. Processing requires energy. Finished products that can be reused many times (or used over a long period of time) make more efficient use of this "energy of formation" than do those whose useful life is very short.

Paperboard, for one example, costs more than 100 times as much energy to manufacture, pound for pound, as does wood. (See chart following, Amount of Energy Required to Process Some Common Materials.) More boxes per ton can be made of paperboard, however, and less human labor is required to finish them than to put together wooden ones. Still, if each kind of box is used only once (as fruit crates are), paperboard cartons cost more energy than wooden ones. Polystyrene baskets (for berries, tomatoes) cost even more energy to make, petroleum itself being the basic stock for its chemical make-up. (See the same chart.) Can you see why some plastic containers may be the "collectibles" or antiques of the future?

Another factor to consider in calculating energy expense for materials is time of their useful lives. How long will this material last in finished form? Compare a pound of paper plates to a ceramic one or a pair of plastic ones. What is the useful life of the several paper ones vs. one ceramic one? vs. two plastic ones? To carry the energy cost analysis further, estimate how much energy will be required for maintenance of the glass and the plastic plates vs. how much energy will be required for disposal of the paper ones over the same time span. The high energy cost of a throw-away society should become obvious.

If you are clothes-conscious, then polyster, acetate, acrylic, and spandex may be familiar words. These fibers are all made from chemicals derived from fossil fuels. Much of the twenty-five billion square yards of fabric produced in the U.S. annually is based on these synthetic fibers which are very energy-expensive compared to cotton and wool. Do they provide longer wearing life to justify their higher initial energy investment? Or are they also luxuries of the Hydrocarbon Age that will become relics of 20th Century America?

Suggested Activity:

1. Have students use mail-order catalogs, and hardware and plumbing suppliers' ads, or have them phone local businesses to get the following prices:

   a. fiberboard shelves, chests, or room dividers vs. wooden ones;

   b. polyester shirts vs. all cotton shirts;

   c. copper vs. plastic pipe;

   d. paper, glass, and plastic plates;

   e. plastic vs. wooden toothpicks;

   f. plastic vs. straw brooms;

   g. steel, aluminum, and copper wire.

2. Estimate the length of useful life for each of the above items and compare it to cost . . . how many dollars/year is it likely to cost?

3. Check the energy investment each item represents on the chart. Did the more expensive items require more fossil fuel input to process their basic material? If not, why are they relatively expensive? Which items on your list would you expect to become most expensive as fuel prices rise?

4. Look at the chart again. When expensive energy becomes a way of life, which industries may have the most difficult time keeping costs down? (Keep in mind that the weight of the product is related to the energy cost on this chart. Miniaturization, where possible, is a viable strategy.)

Amount of Energy Required to Process Some Common Materials

Material	Energy Input BTU x 10^6/ton
Crushed stone	0.1
Wood	0.3
Brick	6.9
Cement	12.4
Flat glass	18.1
Iron casting	25.0
Lead	31.1
Paperboard	36.4
Paper	40.6
Steel casting	46.7
Steel: carbon, cold-rolled	52.7
Aluminum: rolled, forged, cast	75.0
Zinc: rolled	79.2
Copper: wire	106.2
Copper: rolled	128.0
Nickel	374.7
Tin	469.3
Polystyrene (a plastic)	22,600.0

Data for this table is from Patterns of Energy Consumption in the United States, U.S. Office of Science and Technology, January 1972.

NATIONAL ENERGY EDUCATION DAY PROJECT

NATIONAL ENERGY EDUCATION DAY (NEED) PROJECT

NEED Project

SOURCE: NEED Project
P.O. Box 2518
Reston, VA 22090

Grade Level: (9) (10) (11) (12)

Cost: $12.50/school. Lower with corporate sponsorship

DESCRIPTION/CRITIQUE

The NEED Project was founded in 1980 by a Joint Congressional Resolution to prompt schools throughout the United States to develop comprehensive and ongoing energy education programs. It fosters the growth of an energy educated public and develops student leadership skills. The NEED Project supplies participating schools with resources, while encouraging students and teachers to develop their own programs. Schools are encouraged to submit the work of their students in the NEED Project Youth Awards competition, in which statewide winners are selected and then compete for national honors.

Schools in the NEED Network receive a booklet of activity ideas, organizational hints, an energy play, and three issues of a magazine during the school year. One strength of the program is that students are responsible for determining their own level of participation and learning. Student organizations should consider participating because of the opportunity for leadership development and community involvement.

MATERIALS

Student Activities	X
Teacher's Guide	X
Background Reading	X
Spirit Masters	
Transparency Masters	
Equipment	
A/V	

SUBJECT EMPHASIS

Science	X
Social Studies	X
Home Economics	
Industrial Arts	
Interdisciplinary	
Other: Extracurricular	X

APPROACH

Content Focus	
Process Focus	
Content-Process Blend	X
Discipline Focus	
Interdisciplinary	
Multidisciplinary	X
Infusion	

INSTRUCTIONAL STRATEGIES

Informational Text	
Stories	
Case Studies	
Investigations	X
Games	X
Simulations	X
Group Discussion	X
Debates	X
Demonstrations	
Questions	X

TIME FRAME

Single Class	X
Multi Class	X
Units	
Independent Study	X

Energy Articles

Magazines, those invaluable caches of timely narrative, will yield an immense volume of information on energy with only a little prodding. Stories from the past year include newsworthy items—the achievement of breakeven for nuclear fusion at MIT, the effects of the Iran-Iraq war on petroleum supplies, new fuels from solar energy, more evaluation and study of conventional nuclear power's outlook and economics, the break in funding for the Clinch River breeder reactor—and new benchmark articles on sources familiar or quickly becoming so.

The following list includes articles of both kinds. Both reformulate what we know in light of new developments. The list is designed to be useful as background information for your NEED project or as preliminary overview before you begin.

These articles are only a selection. If you peruse the Reader's Guide to Periodicals (general reading) or the Applied Science and Technology Index (technical reading), you will find many more. Reader's Guide can be found in most libraries; Applied Science and Technology in engineering or science libraries. Happy browsing!

General Articles

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The Energy Carnival

Now that your conference delegates have learned about the BTU and quad and visited the six energy pathway exhibits, they are ready to use this knowledge at the carnival. We have developed six energy games for your carnival teams to participate in. If you have twelve carnival teams, set each game up twice. The energy games we have included are suggestions. Feel free to develop some of your own as well. Use your creativity and imaginzation to help make this activity the highlight of your conference.

The carnival requires that you have a leader to keep track of time and to announce rotations and a moderator stationed at each game.

With each of the games, we have included instructions, sample questions (with answers), and graphics. Choose the questions -- or develop your own -- keeping the age of your conference delegates in mind. Also included is camera ready art for the "energy bucks." Run the $1 energy buck in one color and the $5 energy buck in another for easier distribution.

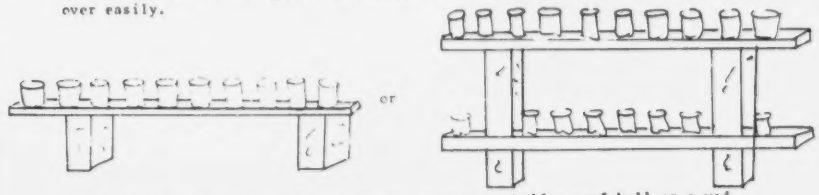
Your teams should choose one person to act as treasurer, collecting and holding onto the energy bucks. Another person can be chosen to act as team spokesperson, or rotate the spokesperson with each game.

At the beginning of the carnival, each team will be assigned a game to start with. At the announcement of the carnival leader, the activity will be officially begun. Teams will be given five minutes to hear the game rules, successfully complete the game, and collect their energy bucks. They will then be instructed to rotate (either clockwise or counter) the the next game area by the carnival leader.

The final objective for each team will be to collect the greatest amount of energy bucks. Suggestions for prizes are in the NEED Leadership Training Conference Guide.

Renewable-Nonrenewable Knockdown

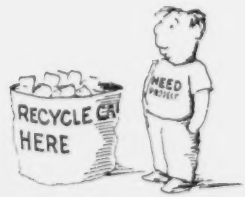
This game is made up with aluminum cans. Enclosed you will find a pattern for covering the cans and appropriate graphics; just add color if you wish. Twenty-three cans are needed in all. Seven cans should have petroleum labels; both natural gas and coal should have five cans covered. Biomass, geothermal, wind, solar, uranium, and hydroelectric should have one labeled can each. This distribution of labels best represents present-day consumption rates. The cans should be arranged on 2x2 boards in one or two levels and should fall over easily.



The ball that is used should not bounce -- such as half a nerf ball or a wad of paper or aluminum foil.

The following are the instructions that should be given to the carnival team:

You will have four chances to knock down two cans of either a renewable or nonrenewable energy source. Two similar cans (renewable or nonrenewable) can be knocked down at once. Once you knock down the two cans, I will ask the team the appropriate question -- either renewable or nonrenewable. If your team answers the question correctly, you will receive $1 energy buck. If not, I will give you the answer and we will then move on. You will be able to repeat the process five times in all. Let a different team member throw the ball each time around.



RENEWABLE - NONRENEWABLE KNOCKDOWN

RENEWABLE SOURCES - Wind, Biomass, Solar, Geothermal, Hydroelectric

Which renewable energy source in 1984 provided America with almost 5% of its total energy demand by suppling 14% of the nation's electrical energy needs.

Hydroelectric

To effectively use solar energy for home heating, large windows should be installed facing what direction?

South

Name one use of solar energy in the home.

Hot water heating
Cooking
Clothes drying
Space heating and cooling
Electricity from photovoltaic cells

Name the term used to describe the heat energy from the earth.

Geothermal

Name one method of utilizing the energy stored in biomass.

Direct combustion (burning)
Convert it into a gas (methane)
Convert it into alcohol

Name the biological process that can convert agricultural waste into alcohol and carbon dioxide.

Fermentation

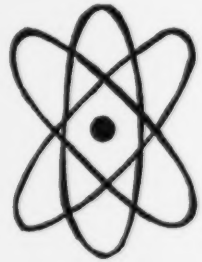
Name the type of alcohol that is blended with gasoline to produce gasohol.

Ethanol

Name the solar home design that stores and releases solar energy with the use of pumps and tubing?

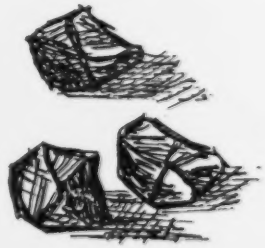
Active solar design

PETROLEUM



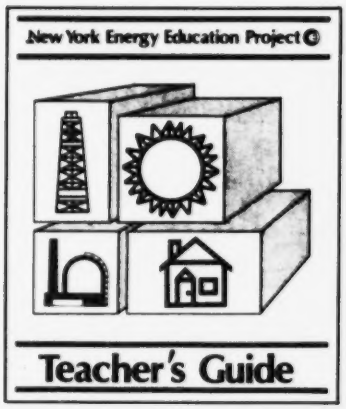
URANIUM

NATURAL GAS



COAL

THE NEW YORK ENERGY EDUCATION PROJECT



STATE UNIVERSITY OF NEW YORK

1984, Copyright

SOURCE: Energy Education Project
SUNY — Albany
1400 Washington Avenue
Box 22100
Albany, NY 12222

Grade Level: (9) (10) (11) (12)

Cost: Activities book - $4.00 each
Teacher's guide - $1.60

DESCRIPTION/CRITIQUE

The activity guides: Energy Conservation, Renewable Energy, Nuclear Energy, and Fossil Fuels contain complete activities with student direction, teacher background, worksheets, and a glossary. The presentation of the subject is even handed and the activities are interesting. Each guide contains a matrix listing each activity and placing it in its grade level and discipline and/or disciplines is helpful.

Both the teacher and student guide contain suggested approaches for teaching these energy activities, including lengths of units from four days to six weeks. Each activity is formatted to include, objectives, skills and knowledge you need, materials, vocabulary, procedure, questions, review, and ideas for additional research on topic. Though there are some activities that could be infused into an existing course of study, they are best used, as suggested, as units. All the materials provided in this packet are useful additions to the whole, making this a well conceived learning unit.

65

MATERIALS

Student Activities	X
Teachers Guide	X
Background Reading	X
Spirit Masters	X
Transparency Masters	X
Equipment	X
A/V	X

SUBJECT EMPHASIS

Science	
Social Studies	
Home Economics	
Industrial Arts	
Interdisciplinary	X
Other	

APPROACH

Content Focus	
Process Focus	
Content/Process Blend	X
Discipline Focus	
Interdisciplinary	
Multidisciplinary	
Infusion	X

INSTRUCTIONAL STRATEGIES

Informational Text	X
Stories	
Case Studies	X
Investigations	X
Games	
Simulations	X
Group Discussion	X
Debates	
Demonstrations	X
Questions	

TIME FRAME

Single Class	X
Multi Class	
Units	X
Independent Study	X

4

A Sun Rights Dilemma

The energy crisis has forced us to explore new energy sources. We know that there is not one energy source that will satisfy all the energy needs of the U.S. So people are coming to realize the importance of alternative forms of energy. One energy source that has always been with us, but has been severely under-utilized, is the sun. Today more and more people are interested in harnessing the sun's energy to provide for some of our energy needs. The wind is another form of energy that has been neglected for many years, but is now attracting new interest.

In this activity you will read about a town that has a dilemma. Some residents want to use solar and wind energy for their homes, but because the town is considered a historic site, zoning laws forbid this kind of change. Some citizens want to keep things just the way they are. A third group of residents feel that energy problems can best be solved by stricter conservation methods, without changing the historic look of the town.

As you read the dilemma, consider the need to protect the rights of all citizens: those who wish to develop alternative sources of energy, those who wish to preserve a historic site, and those who favor conservation. Although the town you will read about is imaginary, the problem is a real one which has arisen in many towns and cities across the country.

objectives

At the completion of this activity you should be able to

- o list 5 possible options that the town should consider to solve the problem, and
- o determine the impact of a specific decision.

skills and knowledge you need

Listening, speaking, reading, and writing as a means of communication

An understanding of the Bill of Rights

Clarifying differences in behaviors and ideas

Making decisions and assessing their impact

materials

copies of the dilemma

an overhead transparency

words you'll learn

Active solar collector: a box with a glass cover, specially designed to collect the sun's energy for space or water heating. Air or liquid is circulated through the collector, heated, and then piped to the point of use. Collectors are usually mounted on the south-facing roofs of houses, or on the south side of a house on the ground.

Passive solar: refers to a house or building that is built in such a manner as to capture the maximum amount of sunlight -- which in turn naturally warms the house. Such structures usually have large window areas on the south side.

Wind-powered generator: a modern type of windmill used to generate electricity. It is usually mounted on a tall tower in an open area on the windward side of the house.

Energy conservation: any of the many techniques for saving energy. These include using more insulation in houses, adding storm windows, cutting down on the use of appliances, driving fuel-efficient cars, recycling, etc.

procedure

1. Read and discuss the "Words You'll Learn" section so that you understand the energy vocabulary used in the dilemma.
2. Divide the class into groups of 4 or 5 and have each group choose a leader.
3. Read the dilemma.
4. Discuss the "Pros" and "Cons" of introducing solar energy into the town -- some have been given to you -- and add to the list until you have 7 of each.
5. Discuss the possibility of introducing laws that might protect citizens wishing to use solar energy.
6. Come up with 5 possible solutions to the dilemma.
7. Appoint a recorder and have that person write your five solutions on an overhead transparency and report them to the class.

questions

1. Should Swift and Johnson have the right to install solar collectors and wind machines on their property? Do they already have the right?
2. Does Mr. Jones still have the right to plant his poplar trees, when he knows that eventually they will cast a shadow on Ms. Swift's solar collectors?
3. Where should the responsibility for protecting the users of solar energy lie -- with the town, the state, or the federal government? Why?
4. If a compromise with the historical society could be reached, do you think active or passive use of solar would be more beneficial? Why?
5. Is energy conservation a better solution than using solar and wind energy? How about in the long run? Can they be used together?
6. Is it possible to protect the "sun rights" of people in cities? Why is this a difficult problem?

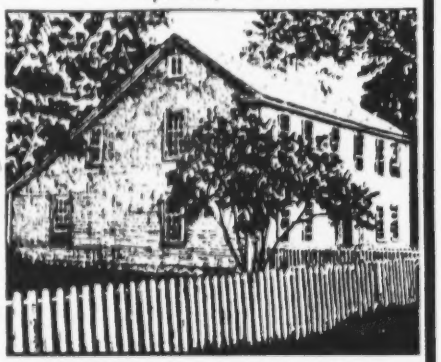
looking back

Coming to understand the energy crisis and how it affects each of us isn't simple. People don't always agree on the solutions, but it is important to understand all possible options and be open to change.

A Sun Rights Dilemma

The year is 1986; the United States' energy crisis has deepened. Gasoline now costs $3.29 per gallon and prospects are that it will hit $4.00 by 1987. The prices of home heating oil and natural gas continue to rise. The energy picture is not bright. Although a number of nuclear plants are still in operation, people have not yet forgotten the incident at Three Mile Island, and few new plants have gone into operation since 1980.

Anytown, U.S.A.



In a small town in the U.S., Anytown, the people are very much aware of the energy crisis that has reached into every home and business across the country. Anytown is a familiar spot to many people. Its history goes back to the 17th century when America was first being settled. The citizens of the town are proud of their heritage and have promoted the town as a historic site. They have preserved the historic character of all the buildings of the town. The town is a tourist attraction and during the summer many families come to enjoy the rich past that is preserved here.

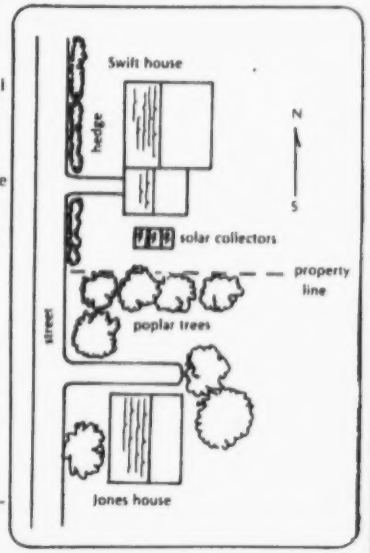
The people of Anytown are conscious that something needs to be done about the energy crisis. Some strongly believe that the way to end U.S. energy dependence on oil (a problem the U.S. has been trying to deal with since 1973) is to enforce stricter conservation methods. Others feel there is a need to develop and emphasize more use of coal and nuclear power. However, another group of citizens in the town has been doing some investigation regarding alternative energy sources -- particularly the use of solar and wind energy. One industrious individual, Ms. Swift, has even gone so far as to construct a small bank of active solar collectors in her yard to show her friends and neighbors how the whole town could benefit from the use of solar energy. At the present time, Ms. Swift uses her active solar collectors to heat the hot water in her home; but she has told her friends that it is also possible to construct a passive solar home which could save thousands of dollars in heating bills.

At the same time, Mr. Johnson is having problems with energy costs at his farm on the edge of town. In order to make himself more energy independent, Johnson intends to install a wind-powered generator on a 30-meter tower to meet most of his energy needs. He plans to contribute any excess to the town electric service. He has applied for a building permit.

Unfortunately, the desire on the part of some of the people to use solar energy has brought about a legal battle within the town. There are a few problems that have to be dealt with and the town council is about to hear the arguments of the people involved. First of all, there exist some strict zoning ordinances in the town regarding what can be built. Since this town is a preserved historic site, laws have been passed that prevent additions to already existing houses or the building of new houses that appear to be out of keeping with the history of

Unfortunately, the desire on the part of some of the people to use solar energy has brought about a legal battle within the town. There are a few problems that have to be dealt with and the town council is about to hear the arguments of the people involved. First of all, there exist some strict zoning ordinances in the town regarding what can be built. Since this town is a preserved historic site, laws have been passed that prevent additions to already existing houses or the building of new houses that appear to be out of keeping with the history of the town. The Anytown Historical Society strongly opposes building passive solar houses or putting solar collectors on the roofs of peoples' houses, as well as the installing of windmills. They maintain that the law forbids such things and plan to see that the law is enforced.

In addition to this, a second set of problems has arisen. After Ms. Swift built her solar collector on her property, Mr. Jones, vice-president of the historical society, who lives next to Ms. Swift, promptly planted five poplar trees, even though the collectors are screened from the street by a hedge. Poplar trees take only a couple of years to grow and provide a great deal of shade. The result is that Ms. Swift's solar collector will soon be useless because of the poplar trees which will shade the collector from the sun. This might force Ms. Swift to abandon her project altogether.



Meanwhile Ms. Fagel, Johnson's neighbor, says that a windmill can make enough noise to bother her on her peaceful farm, as well as interfere with reception on her television. Ms. Fagel is in favor of energy conservation. She says that Johnson could save just as much energy by adding more insulation to his house, and that he should forget about the wind generator. The town is considering denying Johnson's building permit because of her complaints.

The next town meeting will be the arena for discussing the following issues:

1. the historical committee wants stricter enforcement of the zoning laws in the town to prevent the introduction of solar collectors and other innovations to the town. They want present collectors dismantled.

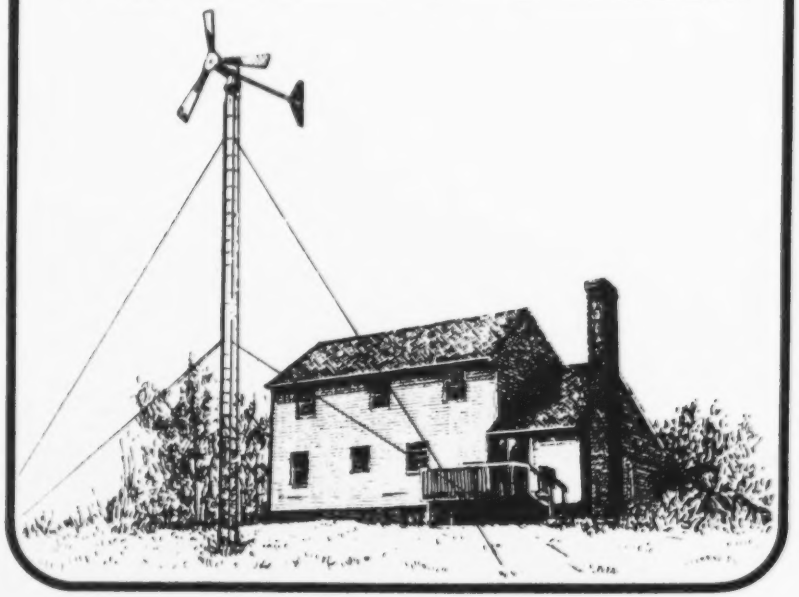
2. Ms. Swift has decided to confront the town with her belief that she has a constitutional right to the sun, and if someone prevents her access to the sun, it is wrong. She wants Mr. Jones to take out the poplar trees which will shade her collector.

3. Mr. Johnson wants to establish just what his rights are as a property holder in his town. Does some group sitting in town office -- elected by him -- have the right to tell him what he can and cannot build on his property?

Now the people in the town are divided into two camps -- those wishing to preserve historic tradition and the financial gain that comes from tourism, and those who wish to introduce solar and wind energy into their homes and change existing laws so that they will be protected. In addition, a third group feels that all the town's energy problems could be solved by more conservation, without needing solar collectors or wind generators.

Now add more Pros and Cons to this list.

Pro-Solar	Anti-Solar
1. will cut down on dependence on oil and electricity	1. disturbs the historic beauty of the town
2. will ultimately be less costly	2. people will stop coming to the town -- will mean a loss of revenue
3. _____	3. _____
4. _____	4. _____
5. _____	5. _____
6. _____	6. _____
7. _____	7. _____



Teacher Information

A Sun Rights Dilemma

Suggested Grade Level and Discipline

Grades 7-9
Social Studies
Language Arts

Skill Objectives

Understanding and applying constitutional rights to solar energy issues

Developing a number of possible options that could be followed to solve the dilemma

Making a decision and assessing its impact

Major Understandings

An alert citizen identifies different positions regarding energy alternatives.

A good decision-maker will analyze and evaluate the positions, weighing the advantages and disadvantages of using solar energy, and will attempt to predict the impact of a specific decision.

Background

We are all acutely aware of the need to conserve energy. More recently Americans are beginning to realize that conservation alone is not the answer to solving our energy crisis. Today we know that alternative energy sources such as solar, wind, or geothermal power do exist as viable energy alternatives. The potential of these sources must be investigated.

In this activity the students are asked to reflect upon two important issues:

1. the value of using solar energy to reduce U.S. dependence on oil;
2. the importance of considering the rights of individuals who wish to experiment with solar energy, and of those who don't.

We must realize that some laws may have to be rewritten in order to protect individuals who wish to solve our energy problems in a more creative manner.

Finally, this activity boils down to having the students negotiate between two values positions: using solar energy to reduce dependence on oil and ultimately save money vs. preserving a historical town that brings in additional funds to the town because it is a tourist attraction.

Advance Planning

Duplicate needed quantities of the dilemma.

Obtain an overhead projector, transparencies, and marking pens.

Suggested Time Allotment

2 class periods

Suggested Approach

Students should be familiar with alternative energy sources; therefore, it is recommended that they do some reading in this area. They might also collect pictures of solar houses and wind generators from magazines. (See References.)

Students should also be familiar with the Bill of Rights in order to apply the concepts to this activity. Briefly review the relevant sections of the Bill of Rights.

Discuss the "Words You'll Learn" with the students.

Divide the class into small groups (4 or 5) and give them each a copy of the dilemma. Have them read the dilemma and then discuss the pros and cons of introducing solar energy into the town. (A partial list is given; they should add to it.)

After each group has had the time to discuss the problems and issues involved, they should come up with a maximum of 5 possible solutions to solve the dilemma.

When the class has completed their brainstorming, a spokesperson from each group could show the solutions on the blackboard or overhead for the entire class to review. The teacher could then lead a discussion to develop the direction the class is moving in. If time permits a simple vote may be taken.

Precautions

Move around from group to group making sure the students are aware of the legal issues involved.

Don't let them get bogged down on any one issue.

Push them to use their creativity when they brainstorm -- brainstorming should be a free, creative exercise.

Encourage the idea of compromising as a means of satisfying the needs of all involved.

Points for Discussion

How do people determine their priorities?

In this case what levels of government might become involved in the issue? Would the problem remain on the local level or might the state or perhaps even the federal government step in to legislate here?

When there is no question of right or wrong, on what basis does a responsible person make decisions?

How absolute should a property owner's right to do whatever he/she likes on his/her property be?

Evaluation

Students could be evaluated on their next test with an essay question in which they must explain how citizens living in a democracy are protected by constitutional rights and yet must abide by the will of the majority.

Modifications

Students could be assigned to represent the two opposing groups in the town and then could debate the issue of introducing solar energy vs. preserving a historic town.

Students could role play the people involved in the dilemma in a simulated town meeting.

References

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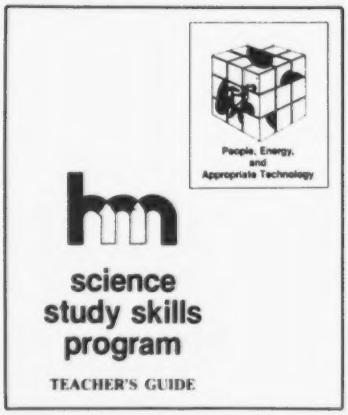
(Southern Solar Energy Center, 61 Perimeter Park, Atlanta, GA 30341, contact SSEC for price.)

PEOPLE, ENERGY, AND APPROPRIATE TECHNOLOGY



NATIONAL SCIENCE TEACHERS ASSOCIATION

1983, Copyright, Carol Wilson and Gary Krasnow, Authors

SOURCE: Request "The hm Science Study Skills"
National Science Teachers Association
1742 Connecticut Ave., N.W.
Washington, D.C. 20009

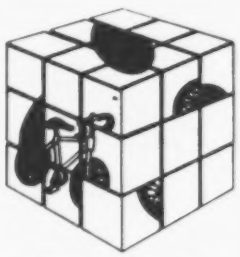
Grade Level: (9) (10) 11 12

Cost: $ 4.50 Student Text
7.50 Teachers Guide
16.50 Workshop Unit

DESCRIPTION/CRITIQUE

Developed to help students, grades 7-10, learn the necessary study skills to learn science. The fourteen activity oriented units integrate scientific concepts with such skills as graph reading, note taking, science vocabulary, using scientific measuring tools, and test taking. The first eight units help the students establish criteria by which they can judge the appropriateness of a technology (solar greenhouse); and the last section gives the students an opportunity to apply what they've learned.

Most units would take a class period to complete and can be adapted to varying abilities. The student text is both a classroom workbook and a text for energy and appropriate technology. The Teacher's Guide lays out each lesson with directions and necessary preparation. The program is best taught as a complete unit in an ongoing science course.



People, Energy,
and
Appropriate Technology

MATERIALS

Student Activities	X
Teachers Guide	X
Background Reading	
Spirit Masters	
Transparency Masters	
Equipment	
A/V	

SUBJECT EMPHASIS

Science	X
Social Studies	
Home Economics	
Industrial Arts	
Interdisciplinary	
Other	

APPROACH

Content Focus	
Process Focus	
Content/Process Blend	X
Discipline Focus	X
Interdisciplinary	
Multidisciplinary	
Infusion	

INSTRUCTIONAL STRATEGIES

Informational Text	X
Stories	
Case Studies	X
Investigations	X
Games	
Simulations	
Group Discussion	X
Debates	
Demonstrations	
Questions	X

TIME FRAME

Single Class	
Multi Class	
Units	X
Independent Study	

UNIT V: MAKING JUDGMENTS
and
HOW DOES TECHNOLOGY AFFECT THE ENVIRONMENT?

STUDY SKILLS

We often ask students to make comparisons and judgments in science. Comparing and judging are complex processes which need to be broken down into simpler steps for students to master.

This unit presents students with two considerations involved in making judgments or decisions. First, students learn that they need facts in order to make sound decisions and that facts are different from opinions.

Second, students are introduced to the use of criteria to help them judge different sets of facts. They are asked to rate several energy technologies using a given list of criteria.

ENERGY AND THE ENVIRONMENT

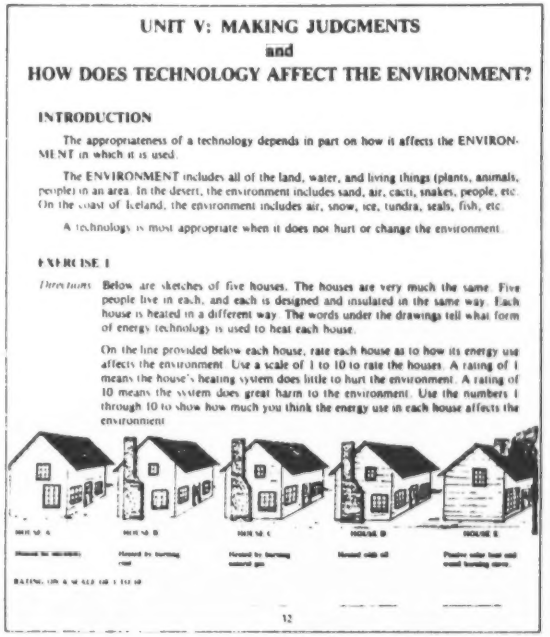
All technologies have some impact on the environment. Appropriate technologies, however, tend to have fewer negative effects on the environment than other technologies. Environmental impact is another factor in evaluating the appropriateness of a technology.

This unit presents students with a set of criteria for judging the effects of five different home heating technologies on the environment. Students are asked to use these criteria to rate different methods of home heating. The criteria given are:

1. The technology should have minimal short and long term effects on living things.
2. The technology should not make the environment look or smell unpleasant.
3. The environment should be able to recover quickly from the impact of the technology.
4. The technology should produce little waste material.

NOTE: The facts provided for students in this unit provide a basis from which students can begin to make judgments about the relative effects of different technologies on the environment. However, the facts are inconclusive. No one yet knows enough about the long term effects of these technologies to make absolute judgments. One of the purposes of this unit is to help your students begin to see how difficult it is to evaluate the long term effects of technologies.

In Exercise I, your students will probably be frustrated by the lack of criteria with which to make an evaluation. Even with the additional information provided for Exercise III, your students may still experience some frustration with the lack of criteria and facts for making a judgment. As you will see on page 43, there are no "right" answers to this problem. When students raise concerns about their frustrations, help them to see the need both for clear criteria and more facts to solve this problem more adequately. Explain that such information is not yet available, and encourage them to continue to seek the information needed to make decisions about these technologies in the future.



UNIT V: MAKING JUDGMENTS
and
HOW DOES TECHNOLOGY AFFECT THE ENVIRONMENT?

INTRODUCTION

The appropriateness of a technology depends in part on how it affects the ENVIRONMENT in which it is used.

The ENVIRONMENT includes all of the land, water, and living things (plants, animals, people) in an area. In the desert, the environment includes sand, air, cacti, snakes, people, etc. On the coast of Iceland, the environment includes air, snow, ice, tundra, seals, fish, etc.

A technology is most appropriate when it does not hurt or change the environment.

EXERCISE I

Directions: Below are sketches of five houses. The houses are very much the same. Five people live in each, and each is designed and insulated in the same way. Each house is heated in a different way. The words under the drawings tell what form of energy technology is used to heat each house.

On the line provided below each house, rate each house as to how its energy use affects the environment. Use a scale of 1 to 10 to rate the houses. A rating of 1 means the house's heating system does little to hurt the environment. A rating of 10 means the system does great harm to the environment. Use the numbers 1 through 10 to show how much you think the energy use in each house affects the environment.

12

Suggested Directions for Unit V

1. Organize your class into groups of three or four.

2. Ask students to read the "Introduction" (page 32) to themselves. Discuss the concept of environment with students, giving other examples of different environments or asking students for examples.

   Approximate time: 5 minutes

3. Have students read the directions for Exercise I (page 32). Clarify the rating system if it is unclear to students. Emphasize that each of the houses is to be rated individually, not in comparison with other houses.

   Ask students to complete Exercise I in their groups. Because students are not yet given the specific criteria with which to make their judgments at this point in the unit, they may find this exercise frustrating. Do not give students more than 10 minutes to complete Exercise I.

   After 10 minutes, ask one student from each group to report the group's ratings. Ask students on what basis they made their decisions, and what might have helped them make a better judgment about each house.

   15 minutes

MAKING JUDGMENTS: FACT AND OPINION

How did you decide on a rating for each house in Exercise I? Did you have the information you needed to make a good decision?

Making good choices or judgments often depends on having the *facts*. Without facts, you may end up basing your choice on *opinion* only.

A *fact* is something (events, pieces of information, data) which is accepted as true.

An *opinion* is a person's idea or belief. People may have different opinions or interpretations of the same event, data, or experience.

Example: *Fact:* John has brown hair.
Opinion: John's hair is beautiful.
Fact: The sun will set at 7:02 p.m.
Opinion: My view of the sunset is better than yours.

EXERCISE II

Directions: Below are five sentences about strip mining for coal. Each sentence is either a fact or an opinion. In the space provided next to each sentence, write *fact* if you think it is a fact, or *opinion* if you think it is an opinion.

fact 1. Strip mining is the least expensive way to remove coal from the earth.

opinion 2. The least expensive way is always the best for everyone.

fact 3. In strip mining, soil and rock are stripped away so that the coal can be collected.

fact 4. It often takes thousands of years before dry areas that have been strip mined return to their natural condition.

opinion 5. Coal is the most valuable resource in the U.S. today.

MAKING JUDGMENTS: USING CRITERIA

Once you have found the facts which will help you make a judgment, you need a way of comparing them. It is useful to develop CRITERIA or standards against which you can judge your information.

Example: Below are 4 *criteria* useful in judging how different kinds of energy technology affect the environment.

1. The technologies should have little immediate or long term effect on living things.
2. The technology should not make the environment smell or look unpleasant.
3. The environment should be able to recover quickly from the technology.
4. The technologies should not produce a lot of waste material.

33

4. Have students read "Making Judgments: Fact And Opinion" (page 33) to themselves, or read it aloud. Go over the Example (page 33) with students. Ask students to generate other examples to indicate their understanding of the difference between facts and opinions.

   5-10 minutes

5. Have students read the directions to Exercise II (page 33) and complete the exercise in their groups. Have groups compare their responses. Discuss as necessary.

   5-10 minutes

6. Read "Making Judgments: Using Criteria" (page 33) aloud, or have a student read it aloud. Then, read the four criteria in the Example (page 33), and discuss these as standards by which different technologies can be judged.

   5-10 minutes

EXERCISE III

Directions: Your teacher will give you some facts about each house you rated in Exercise I. Each set of facts includes information about the effects of the energy technology used on the environment.

Read the information about each house. As a group, rate each house again on its effect on the environment. This time, use the facts you have been given and the criteria listed above in making your judgments. Put your ratings below the houses below.

Use the same rating system you used in Exercise I to rate the houses. On a scale of 1 to 10: 1 means a house that does little to damage the environment, and 10 means a house that harms the environment a great deal.

6	7	4	5	5

34

7. Ask students to read the directions to Exercise III (page 34). Distribute the information about the houses, found on the following pages, to the groups. You may want to give each group one copy of the information and ask them to share it. This promotes listening skills and group cooperation. Have extra copies to give to students after the exercise for later reference. Emphasize again that each house should be rated individually, not in comparison with the other houses.

   Note that the information given about House A suggests that electricity could be produced by fossil fuel or nuclear fission. Students should base their judgment about House A on whichever form of production is prevalent in their area.

   When students have completed Exercise III, ask a student from each group to present the group's ratings. Compare group results and discuss similarities and differences. Refer students back to the *facts* in the readings and the *criteria* in the Example on page 33 if they find wide discrepancies in their judgments.

   Ask students if they needed still more information in order to make good judgments. Explain that such information is not yet available, and encourage students to be alert to further information about the effects of energy technologies on the environment.

   20 minutes

NOTE: As explained in the Note on page 40, there are no "right" answers to this exercise. The answers given are suggested, based on the facts available but also on opinions. You may want to use these answers. Or, you may want to evaluate the five houses yourself, and use the rankings which you generate. With either option, what is important is that you help your students understand both the need to evaluate the environmental costs of technologies and the difficulties in doing such evaluation.

HOUSE A

This house has electric resistance heating. It uses approximately 25,000 kilowatt-hours of electricity a year. At the house, it produces no pollution or waste. But electricity must be generated in some way. If coal, oil, and natural gas are used, the pollution and other harmful effects will be similar to those described for Houses B, C, and D.

If nuclear fission is used, there is a small amount of highly radioactive waste produced each year which must be stored away for hundreds or thousands of years. Otherwise, it could cause an increase in diseases such as cancer and leukemia. Permanent ways of getting rid of or storing the waste are being studied, but at present storage is usually at the power plant and considered "temporary."

The power plant (where the electricity is produced) gives off no carbon dioxide, no nitrogen, no particles. However, water used for cooling purposes is often returned to nearby rivers warmer than it was when it was taken out. The change in temperature affects the plants and animals in that part of the river.

HOUSE B

This house has an airtight coal burning furnace. It uses four tons of anthracite coal, which produces two or three times as many particles in the air as the wood used in House E. The coal also produces large quantities of sulfur oxides, which combine with water in the atmosphere to form sulfuric acid. This acid corrodes metal and stone surfaces. When it rains, the sulfur oxides and acids are washed into lakes and streams, increasing the acidity of the water. The effect of this increased acidity is not yet fully understood, but scientists believe it may damage the plant and animal life in these bodies of water. Small amounts of carbon monoxide are also produced by this coal burning furnace.

The mining of this coal, usually by underground methods rather than strip mining, can be dangerous to the miners. It can also lead to underground fires in abandoned mines and cause acid runoff into streams near the mine.

HOUSE C

This house has a gas furnace. It consumes 1,400 hundred cubic feet of natural gas each year, which produces little pollution where it is burned.

The production of natural gas creates several kinds of pollution. It damages vegetation in the environment and makes the air around the production plant unhealthy to breathe.

Natural gas is also highly flammable. Producing and shipping it create the risk of explosion and fire. Gas is shipped as liquified natural gas, and extreme care must be taken as it is unloaded to be sure that no leaks occur.

HOUSE D

This house is heated with oil. It consumes 1,000 gallons each year which produce small amounts of sulfur oxides and carbon dioxide when burned. Offshore drilling of oil and spills from tankers carrying this fuel pose danger to the plant and animal life of the oceans. The danger is not fully understood, but oil is absorbed into the bodies of marine animals and is known to cause cancer. In Arctic regions, an oil spill could blacken ice, causing it to melt more quickly. This could cause widespread climate changes.

HOUSE E

This house has the same amount of window glass as the other houses, but there are no windows on the north side. These windows have been moved to the south side of the house. This house has been positioned so that trees and bushes will not block the south side in the winter. This allows the house to make full use of the sun's energy. Leaves on the trees provide shade in the summer.

This house uses wood burned in an airtight stove to provide back-up heating. Two cords of wood are used during a typical heating season. This amount of wood requires the cutting of several trees and causes pollution in the form of particles of carbon and carbon monoxide. These particles may make the air difficult to breathe. They may also cause cancer. The particles wash out of the air when it rains, darkening snow and tree trunks. The carbon monoxide changes to carbon dioxide fairly quickly. Carbon dioxide contributes to the "greenhouse effect," which will be studied in later units. Many scientists predict that an increase in the carbon dioxide level of the atmosphere will raise the world's temperature and trigger worldwide climate changes.

UNIT V SUMMARY

MAKING JUDGMENTS

To make good decisions or judgments, you need to have *facts* so that your decision is not based on *opinion* alone.

A *fact* is something which is accepted as true. Data you gather in science are facts.

An *opinion* is a person's idea or belief. Once you have facts or data, you can make interpretations or form opinions.

You also need to have *criteria* which serve as standards against which you can judge the facts you gather. Facts give you the information you need. Criteria help you use the facts to make judgments or decisions.

APPROPRIATE TECHNOLOGY AND THE ENVIRONMENT

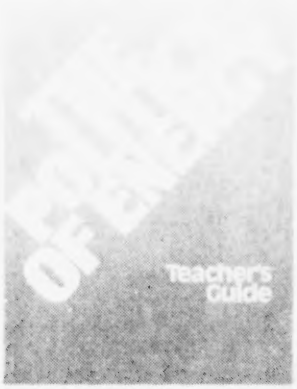
The *environment* is the land, water, and living things in a particular area. A technology is most appropriate when it does not hurt or change the environment.

Four criteria for judging whether or not a technology is appropriate in its effects on the environment are:

1. The technology has little short or long term effect on living things.
2. The technology does not make the environment smell or look unpleasant.
3. The environment can recover from the technology quickly.
4. The technology does not produce a lot of waste material.

POLITICS OF ENERGY

INNOVATIVE COMMUNICATIONS



1981, Copyright by So. Cal. Edison Co., L.A. Dept. of Water and Power, Sacramento Muni. Utility Dist.

SOURCE:
Innovative Communications,
2923 N. Main St.
Walnut Creek, CA 94596

Grade Level: 9 10 (11) (12) **Cost:** $49.50/classroom set

DESCRIPTION/CRITIQUE

This is a simulation activity designed to teach students the "give and take" of political interaction. Specifically, it focuses on the legislative process by which a bill becomes a law. Each student is assigned a role, e.g. senator, member of an interest group, etc., to play during the debates, negotiations, and final vote on the bill which make up the simulation. For the role playing activities, students consult a newspaper that provides descriptions of the characters. To help them understand the issue, the kit contains a journal on energy topics and a computer (Apple II or TRS) database which may be manipulated by the students as they seek support for their position.

A classroom set contains all materials necessary for conducting this simulation. The set includes a printout of the database and, thus, can be used even without a computer. Simulation data is from 1981, but this does not drastically reduce the useability of the unit because the focus is more on the legislative process than the energy information. A considerable amount of time is necessary to get the simulation going, but this is compensated by the activity sustaining itself with little additional input for up to three weeks.

MATERIALS

Student Activities	X
Teacher's Guide	X
Background Reading	X
Spirit Masters	
Transparency Masters	
Equipment	X
A/V	X

SUBJECT EMPHASIS

Science	
Social Studies	X
Home Economics	
Industrial Arts	
Interdisciplinary	
Other	

APPROACH

Content Focus	
Process Focus	X
Content Process Blend	
Discipline Focus	X
Interdisciplinary	
Multidisciplinary	
Infusion	X

INSTRUCTIONAL STRATEGIES

Informational Text	X
Stories	
Case Studies	
Investigations	
Games	
Simulations	X
Group Discussion	
Debates	X
Demonstrations	X
Questions	X

TIME FRAME

Single Class	
Multi Class	X
Units	
Independent Study	

SPOTLIGHT ON THE SENATE

Seasoned observers of the state senate are beginning to count the number of "aye" and "no" votes which are likely to be cast in the upcoming roll call on the red-hot energy conservation bill now before the Senate Committee on Public Utilities, Transit and Energy.

One of the means for predicting who will cast what vote is analyzing the track record and background—both personal and political—of each senator.

In order that our readers might engage in some crystal ball gazing of their own, the Register-Dispatch has compiled a "thumb-nail" biography on each of the 38 state senators.

Information includes the previous voting records of each senator, as rated by the traditionally oriented Council for Energy Responsibility (CER), and the alternatives-oriented National Committee for Energy Awareness (NCEA).

DISTRICT 1:

Occupation: Lawyer — Political Party/Position: Liberal Democrat
Type of District: Urban
Tenure: 2nd term — % of Vote in last election: 72%
Political Stability: Safe seat
Political Prospects: Regarded as party "Bright Light"
Senate Committees: Public Utilities, Transit and Energy; Finance
Dominant Economic Interests in District: Light manufacturing
Major Campaign Contributors: Labor unions
Energy Issues Voting Record: N.C.E.A. — 80%; C.E.R. — 22%
Pet Programs/Dislikes/Specialties: Law firm specializes in representing unions in negotiations with management
Age: 41 Marital Status: Married, two children
Ethnicity: White Religion: Jewish
Education: B.A., University of Southern California; J.D., University of California Law School

DISTRICT 2:

Occupation: Small business owner — Political Party/Position: Conservative Democrat
Type of District: Small town
Tenure: 5th term — % of Vote in last election: 70%
Political Stability: Safe seat
Political Prospects: Likely candidate for speaker
Senate Committees: Public Employment and Retirement; Government Organization
Dominant Economic Interests in District: Agricultural supplies and machinery
Major Campaign Contributors: Farm machinery trade association; Agribusiness
Energy Issues Voting Record: N.C.E.A. — 47%; C.E.R. — 55%
Pet Programs/Dislikes/Specialties: Has supported growth of corporate farming
Age: 60 Marital Status: Married twice; first spouse deceased; two children
Ethnicity: White Religion: Methodist
Education: B.A., Whittier College

DISTRICT 3:

Occupation: Business executive — Political Party Position: Conservative Republican
Type of District: Urban
Tenure: 3rd term — % of Vote in last election: [illegible]
Political Stability: Safe seat
Political Prospects: Slated for chairmanship of select comm. on public education finance
Senate Committees: Education; Agriculture and Water Resources
Dominant Economic Interests in District: Financial
Major Campaign Contributors: National Association of Manufacturers
Energy Issues Voting Record: N.C.E.A. — 27%; C.E.R. — 71%
Pet Programs/Dislikes/Specialties: Strongly in favor of "Back to Basics" movement in public education
Age: 42 Marital Status: Single, no children
Ethnicity: White Religion: Episcopalian
Education: B.S., University of Pittsburgh; M.B.A., Duquesne University

DISTRICT 4:

Occupation: Lawyer — Political Party/Position: Liberal Democrat
Type of District: Ghetto
Tenure: 2nd term — % of Vote in last election: 95%
Political Stability: Safe seat
Political Prospects: Likely to run for Congress next election
Senate Committees: National Resource and Wildlife; Government Organization
Dominant Economic Interests in District: Heavy manufacturing
Major Campaign Contributors: Revivalist Christian Church Association
Energy Issues Voting Record: N.C.E.A. — 91%; C.E.R. — [illegible]
Pet Programs/Dislikes/Specialties: Nature Conservancy
Age: 42 Marital Status: Married, three children
Ethnicity: Black Religion: Baptist
Education: B.S., University of Missouri; J.D., University of Missouri

DISTRICT 6:

Occupation: Lawyer — Political Party/Position: Liberal Republican
Type of District: Suburban
Tenure: 1st term — % of Vote in last election: 60%
Political Stability: Questionable seat
Political Prospects: Single issues candidate
Senate Committees: Public Utilities, Transit and Energy; Finance
Dominant Economic Interests in District: Bedroom community; Management; Professional
Major Campaign Contributors: Mass transit manufacturers; Public transportation advocates
Energy Issues Voting Record: N.C.E.A. — 75%; C.E.R. — 22%
Pet Programs/Dislikes/Specialties: Statewide, high-speed, mass transit system
Age: 35 Marital Status: Married, two children
Ethnicity: White Religion: Roman Catholic
Education: B.A., Hofstra College; LL.B., Cornell University Law School

DISTRICT 7:

Occupation: Banker — Political Party/Position: Conservative Republican
Type of District: Urban
Tenure: 3rd term — % of Vote in last election: 69%
Political Stability: Safe seat
Political Prospects: Considering running for Governor in next election
Senate Committees: Finance needs; Judiciary
Dominant Economic Interests in District: Defense
Major Campaign Contributors: Fashion industry
Energy Issues Voting Record: N.C.E.A. — 14%; C.E.R. — 80%
Pet Programs/Dislikes/Specialties: Deregulation of energy industry
Age: 46 Marital Status: Married, four children
Ethnicity: Asian Religion: Buddhist
Education: A.B., University of California, Berkeley

DISTRICT 8:

Occupation: Civil Service — Political Party/Position: Liberal Democrat
Type of District: Urban
Tenure: 1st term — % of Vote in last election: 55%
Political Stability: Questionable seat
Political Prospects: Has held crucial vote in last two Senate votes on major issues
Senate Committees: Business and Professions; Education
Dominant Economic Interests in District: Civil service
Major Campaign Contributors: Public Employees Association
Energy Issues Voting Record: N.C.E.A. — 68%; C.E.R. — 33%
Pet Programs/Dislikes/Specialties: Favors binding arbitration for public employees
Age: 46 Marital Status: Married, one child
Ethnicity: Native American Religion: Methodist
Education: B.S., University of Washington

DISTRICT 9:

Occupation: Importer — Political Party/Position: Conservative Republican
Type of District: Suburban
Tenure: 2nd term — % of Vote in last election: 51%
Political Stability: Predicted to lose next election
Political Prospects: Has recognized that strong stance in last term alienated important segments of own party; shifting position now
Senate Committees: Business and Professions; Government Organization
Dominant Economic Interests in District: Light manufacturing
Major Campaign Contributors: American Conservative Alliance
Energy Issues Voting Record: N.C.E.A. — 5%; C.E.R. — 98%
Pet Programs/Dislikes/Specialties: Believes in required public service for all youth
Age: 64 Marital Status: Married, three children
Ethnicity: White Religion: Moslem
Education: B.A., University of California at Los Angeles

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Sacramento Municipal Utility District

Procon '80's

WATTS WITH UNCLE SAM?

The following columns represent two opposing views of the role government should play in regulating the various sectors of the energy industry. The authors are prominent spokespersons for the respective interests their views represent.

Why The Government Must Regulate Energy

By Professor Jackson Deering
Pacific Institute of Social Planning

The supply, production and distribution of energy in the United States in recent years has become a major concern of the American government. In its own turn, each administration from Richard Nixon on has had to grapple increasingly with a seemingly endless succession of energy-related problems. Among the reasons for this escalated governmental involvement, three factors stand out as principal motivators.

First, throughout the history of energy production in the United States, the private sector of the economy has competed to provide low cost fuel and electricity to the consumer. But the competition was at the expense of our non-renewable fossil fuels such as oil and natural gas. This approach was formed when oil was abundant. With a principal obligation to their shareholders, companies freely spent our resources to maximize profits.

Secondly, the U.S. couldn't produce enough oil to meet its own needs, so it became dependent on Mideastern oil, thereby placing our fate and our fortunes in the hands of foreign powers. The bubble of false security was broken by the Arab oil embargo of 1973-74, when we discovered we needed a middle-man who could wean us from this over-dependency.

Thirdly, because of the location of the resources (coal in the Northeast, oil in Oklahoma/Texas, hydroelectric in the Northwest), a series of power generation complexes developed with little interaction between them. There was no overall concept of national need or national distribution. The threat of blackouts in various sectors of the country underscored the need for planning and cooperation between regions.

Glaring deficiencies in U.S. energy supplies, production, and distribution, revealed by the oil crisis of 1973, brought home the critical need for a national energy policy. Free enterprise responded with minimal enthusiasm.

It became apparent that a secure flow of energy was as essential to the U.S. as good police protection and pure water were to each community. But letting private industry work for itself (or its shareholders) resulted in the creation of an exclusive club of inefficient energy suppliers, unresponsive to national needs. The private energy industry had failed to serve the American public wisely.

With public suspicion over the authenticity of the energy crisis at a high pitch, the government finally had to step in and begin to make sense out of the tangled dilemma in which the nation found itself.

The United States cannot endure another such episode.

Needless to say the oil companies, private utilities, and coal producers are chafing under the controls that this regime had to impose. Their frustrations and criticisms, however, are voiced in terms of an energy world that no longer exists: the world in which "free" enterprise, in an atomistic market, guided by the "invisible hand" of Adam Smith, would soon solve all our energy problems.

That world, if it ever existed at all, is no longer with us.

Government Has Gone Too Far!

By Dr. Gertrude Baker
Social Perspectives Collegium

No one denies today that government at every level has a legitimate role to play in the American economy. Provision for the minting of money, the installation of harbor facilities, the reasonable protection of consumers and the maintenance of national defense are services the government should provide for the American people.

Today, however, government intrusion into every sector of the economy has become so widespread that it is reducing the ability of the American People to benefit from the free exercise of capitalism.

One area of the economy that is presently suffering from foolish and irresponsible interference from the government is the energy industry. Layer after layer of bureaucratic regulatory agencies have been established to oversee the production and distribution of electric power and fuel.

Environmental controls restrict utilities from utilizing the cheapest available fuels or require expensive design modifications adding to the basic cost of energy.

State and federal commissions regulate the placement and construction of power generating facilities, making the lead time for new electrical generating capacity so great that costs for construction sometimes triple or quadruple as inflation eats away at utility company assets.

Energy commissions with plenipotentiary power utilizing new legislative mandates, restrict a utility's ability to price its products in accordance with rising costs and a fair return to their shareholders.

Perhaps most annoying of all has been the flood of new government forms for every imaginable statistic from the number of metal chairs in the office to the population of snail darters behind the dam. Utility companies have estimated that millions of dollars from our utility bills go to satisfying the unquenchable appetite of government agencies for information.

American ingenuity and free enterprise must be free to operate in a positive economic environment if we, as a people, want to reap the benefits of efficient production.

Utility companies and oil refineries are no different than any other producer in the marketplace; they must compete to survive. Restricting their ability to compete by loading them down with nonprofit-producing activities such as excessive environmental controls, unreasonable restrictions in construction and fair price control practices, works against the consumer rather than for him.

Take away those restrictions and the oil companies and utilities will have greater incentive to take the economic risks necessary for discovering new oil, building new plants, making nuclear energy safer, and decreasing the cost of energy to the consumer.

US AVERAGE FUEL PRICES TO CONSUMERS, OCTOBER, 1980

FUEL	SEE BELOW	$/MBTU
GASOLINE-1	122.00	8.85
DIESEL-1	86.00	6.24
HEAT OIL-1	99.00	7.15
NAT GAS-2	41.00	4.12
WOOD-3	100.00	3.57

CENTS PER 1-GAL, 2-THERM; 3-DOLLARS PER CORD

DOE MONTHLY ENERGY REVIEWS

HISTORY OF US OIL PRICES (CURRENT $/BBL)

YEAR	DOMESTIC PRICE	IMPORTED PRICE	PERCENT IMPORTED	COMPOSITE PRICE
1964	2.9	1.8	13.6	2.7
1970	3.2	1.8	12.6	3.0
1975	7.7	12.4	33.9	9.3
1976	8.2	13.5	40.5	10.9
1977	8.6	14.5	45.7	12.0
1978	9.0	14.6	43.3	12.5
1979	12.6	21.7	44.0	17.7
1980	23.9	35.1	43.0	29.8

U.S. ENERGY DATA BOOK, 1980, GENERAL ELECTRIC

HISTORY OF US OIL AND COAL PRICES
ACTUAL (CURRENT) DOLLARS

YEAR	OIL-$/MBTU(1)	BITUMINOUS COAL-$/MBTU(2)	RATIO
1964	0.47	0.18	2.61
1970	0.52	0.26	2.00
1975	1.60	0.83	1.93
1976	1.74	0.84	2.07
1977	1.89	0.90	2.10
1978	1.94	0.98	1.98
1979	3.17	1.10	2.88

(1) COMPOSITE PRICE OF DOMESTIC AND IMPORTED OIL.
(2) DOES NOT INCLUDE TRANSPORTATION COSTS.

DOE ANNUAL REPORT TO CONGRESS

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Components (continued)

Teachers' Annotated Guide To The Databank

Each of the tables in the databank provides students with information about some aspect of energy use, energy resources or energy economics. (State and regional data, more personally applicable to a given group of students, is generally available from local utilities and/or the state energy office.)

Since students differ in research skills and the ability to draw useful generalizations from numerical tables, the following "Annotated Guide to the Databank" has been provided.

Needless to say, all the data students will need is not included in the databank, so other sources are essential.

I. ENERGY USE

1979 U.S. Energy Use (Quads)

This table presents a breakdown by major economic sector of the total estimated energy consumption by fuel source in quads or quadrillions of BTU's. It can be useful in estimating which energy sources were most or least important in planning significant cutbacks for various use sectors.

History of U.S. Energy Use (Quads)

This table shows the amount of energy the U.S. has derived from each of the major energy sources over the past 130 years. The information from this table can be useful in supporting arguments for considering traditional energy sources, conserving traditional energy sources or for proposing increased use of alternative energy sources.

History of U.S. Energy Supplies

In conjunction with the table on energy use, this chart can be used to show the increasing dependence the U.S. has on coal and oil.

History of Electrical Energy Growth (Quads)

This table charts the increasing share of total energy growth that has been realized in the electric utility industry. It lends considerable weight to arguments focused on preserving the utilities' use of fuels in contrast to other sectors of the economy.

History of U.S. Electrical Energy Production

This table shows the degree to which the utilities have been able, over the years, to meet the growing demand for electricity. The chart supports the idea, that given incentives, utilities can continue to meet the demand for electric power.

1978 Regional Energy Use for Electricity (Quads by Source)

This table repeats the format of the chart on total energy use, but shows regional use of electricity specifically. (Note: the regional designations shown here are U.S. Census Regions; the state breakdown is as follows: New England – ME, VT, NH, MA, CT, RI. Mid Atlantic – NY, PA, NJ. East North Central – WI, MI, IL, IN, OH. West North Central – ND, SD, MN, IA, NB, KS, MO. South Atlantic – WV, VA, MD, DE, NC, SC, GA, FL. East South Central – KY, TN, MS, AL. West South Central – OK, AR, TX, LA. Mountain – ID, MT, WY, NV, UT, CO, AZ, NM. Pacific – AK, WA, OR, CA, HI.

1978 U.S. Electrical Generating Capacity (1000 MW)

This table shows the electrical generating capacity of various census regions of the U.S. by source. By comparing this table with the preceding regional chart, discrepancies in capacity for generation, fuel alternatives and energy use can be noted.

Fossil Electric Additions (1000 MW)

This table shows the most recent projections regarding increased capacity for the generation of electricity in the U.S. from coal and oil/gas sources. This chart can be useful to students in attempting to make reasonable restricted oil use projections for the modification of S.B. 1600.

Nuclear Power Development (1000 MW)

This chart traces the development of nuclear power over the last twenty five years. From this table students can extrapolate the role of nuclear energy in future electrical power generation.

1980 Fuel and Electricity Use (Quads)

This chart shows the relative use of fuels and electricity by energy use sector. The table can be useful to a number of interest groups in supporting or opposing mandatory curtailment of electrical energy use by the various class users.

1979/1980 Gross Energy Distribution to Residential, Industrial, Commercial and Transportation Uses

These charts cite the major energy use categories, by quads and percent, for each of the four consumer classifications. Students using these tables can make decisions about where energy consumption can and should be reduced the most.

Gross National Product and Energy Consumption

This chart shows the relationships between the growth of the U.S. Gross National Product, the energy consumed and the cost of that energy. Students using this chart can make some estimates about the likely costs in GNP with specific reductions in energy use.

History of U.S. Energy Use (Thousands BTU/capita)

This chart displays the historical growth of U.S. energy consumption in terms of BTU's/capita. The table puts into perspective what it has cost in the use of resources to reach our present standard of living. Such information will be helpful in projecting the socio-economic impact of potential energy consumption cutbacks.

II. ENERGY RESOURCES

U.S. Coal Resources (1000 Quads)

This table pinpoints the regional availability of coal, both in known and identified terms. In addition, it demonstrates that all coal does not produce the same number of BTU's per pound.

U.S. Recoverable Oil (Quads)

This table provides estimates of the amount of oil that has been identified, and is being inferred, in Alaskan and continental oil fields. This data can be used to speculate on future governmental policy, as it relates to domestic oil exploration and development.

U.S. Recoverable Natural Gas (Quads)

This table provides similar data to the preceding one on oil reserves. In combination with previous tables that show the historic use of natural gas, students can estimate its future potential as a major energy resource.

U.S. Uranium Reserves (1000 Tons Uranium Oxide)

As in the previous charts, this table outlines the estimated resources of uranium available for energy production, at varying prices. Students can note the significance of considering both the quantity available and the relative costs of a resource.

Simulation Schedule and Check List

The following Schedule is provided as a suggested format for the three-week version of the simulation. Obviously, every classroom is unique and therefore may involve modification of the timetable and procedures.

Preteaching activities

☐ 1	Read through simulation materials.	Familiarize yourself with the entire simulation, including the student materials and teacher's guide.
☐ 2	Assess student competence to handle simulation.	Decide to what degree you believe your class or classes can accomplish the objectives, e.g. if you believe that they will find it too difficult to interrelate all of the variables, do the necessary correlations of data, speak or write effectively, modify the simulation by deciding beforehand which elements you will choose to eliminate, or change, and in what way.
☐ 3	Select a student administrative assistant and brief him/her.	Select student administrative assistant(s) to aid you in the organization and implementation of the simulation. Brief them thoroughly on the materials and give them a chance to make recommendations regarding role assignments and procedures.
☐ 4	Check school schedule for conflicts.	Check the school schedule for the next two-to-three weeks to be sure that interruptions or changes can be accommodated.
☐ 5	Inform department chair and principal.	Inform your department chairperson and principal as to what your class(es) will be doing, especially if you expect students to do some independent work with the computers or in the library. If you feel good about it, you might ask them to look in on the simulation as it progresses.
☐ 6	Check with math/science teacher re: availability of computers.	Check on the availability of a computer for use in the simulation. This might require negotiating with the math or science departments on such topics as scheduling, rules and procedures for operation, etc. Be sure to familiarize yourself and your student assistant(s) with how the computer program works.
☐ 7	Introduce the concept of a simulation and conduct a practice role play, if necessary.	If necessary, introduce the concepts of simulation and modeling to the class and make clear what the task of students is to be. Conduct a practice role play situation with the class, if you feel they need the experience.
☐ 8	Plan room arrangements.	Decide what room modifications you will have to make and what audio-visual equipment, if any, you think will be useful. Assign students the tasks that need to be done.
☐ 9	Notify school newspaper advisor.	Check with the school newspaper advisor and student editor re: coverage of the simulation. Your student assistant might serve as the simulation press officer, responsible for press releases, etc. (**Note:** Coverage of the simulation would make an excellent Journalism class assignment.)
☐ 10	Notify administrator in charge of daily announcements.	Check with the administrator in charge of daily announcements re: the insertion of simulation news throughout the duration of the activity. Such announcements elevate the simulation from "just a lesson" to that of a school event.

Day 1 – Simulation Introduction

☐ 1	Provide brief introduction re: seriousness of the energy situation.	Introduce the simulation. The tone you set today will, to a large extent, establish the simulation exercises as an important classroom assignment. This can be underscored by emphasizing the seriousness of the energy situation. It is crucial that your introduction be thorough, that students take notes, and that their questions and doubts are accommodated. A business-like approach at the outset will insure that your students feel the exercise is important.
☐ 2	Hand out the "Register-Dispatch".	After your brief introduction, hand out the "Register-Dispatch" newspaper. Discuss its importance as a major resource for the simulation.
☐ 3	Administer the Public Opinion Poll, collect.	Have the students take the short Public Opinion Poll (pre-test) printed in the newspaper. Collect the polls and have the student assistant record the results.
☐ 4	Discuss simulation objectives and rules.	Go over the simulation student objectives, rules, procedures, schedule and evaluation devices.
☐ 5	Make role assignments.	Make the role assignments according to the procedures you decided on with your student assistant.
☐ 6	Hand out copies of "S.B. 1600".	Hand out copies of the proposed bill, "S.B. 1600." Have the students study it to determine if there are any vocabulary or syntactical problems.
☐ 7	Hand out "Worksheet #1" and assign it for homework.	Hand out "Worksheet #1, Role Analysis," and assign it for homework, along with reading the "Register-Dispatch" and "S.B. 1600." Suggest that the students take notes on the key energy issues and on significant groups and individuals as they read over the materials.

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WIND, WATER, FIRE, AND EARTH

NATIONAL SCIENCE TEACHERS ASSOCIATION

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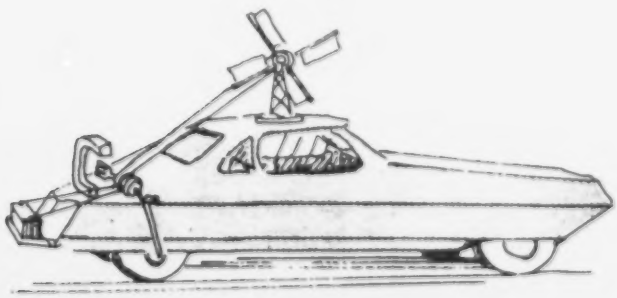
SOURCE: National Science Teachers Association
1742 Connecticut Ave., N.W.
Washington, D.C. 20009

Grade Level: (9) (10) (11) (12) **Cost:** $9.00

DESCRIPTION/CRITIQUE

This is a collection of nineteen energy lessons for the physical sciences designed to bring applied energy concepts into the curricula of standard science courses. Many of the activities, both laboratory-based and home-work/seat-work, can be used to help students understand how science principles are important outside the classroom in everyday life. Activities cover the following topics: outlook for energy supplies, first and second laws of thermodynamics, the basis of nuclear power and operation of nuclear power plants, biomass conversion, production of synfuels, automobile engines and improving miles per gallon, quality and appropriateness of energy sources, greenhouse effect and global temperature, and the use of water in the extraction and transportation of energy sources and in the generation of electricity.

The activities cover a wide age and subject range; as a result, a teacher would most likely be able to only use a few activities per course. Teachers with access to a science lab should have no trouble using the lesson ideas with a minimum of preparation. Each lesson is pedagogically sound and complete; however, the reference articles are five years old or older and, in one case, the lesson is based upon 1979 data. Teachers interested in presenting current understanding and applications of particular principle will need to locate more recent references.



MATERIALS

Student Activities	X
Teacher's Guide	X
Background Reading	
Spirit Masters	
Transparency Masters	X
Equipment	
A/V	

SUBJECT EMPHASIS

Science	X
Social Studies	
Home Economics	
Industrial Arts	
Interdisciplinary	
Other	

APPROACH

Content Focus	
Process Focus	
Content-Process Blend	X
Discipline Focus	
Interdisciplinary	
Multidisciplinary	
Infusion	X

INSTRUCTIONAL STRATEGIES

Informational Text	X
Stories	
Case Studies	
Investigations	X
Games	
Simulations	
Group Discussion	
Debates	
Demonstrations	X
Questions	X

TIME FRAME

Single Class	X
Multi Class	X
Units	
Independent Study	

Lesson 17
Use of Water in Coal Production

Water, that ubiquitous substance, is linked to coal at every step of the way from mine to power plant. Students are introduced to the coal-water relationship through a reading. They attempt to separate a coal slurry mixture, and review a case study on water quality, water availability, coal pipelines, and coal fields. The essay they write as a summary activity can serve as an evaluation of this lesson.

OBJECTIVES

Students should be able to:

- Describe water use during all phases of coal use—mining, transport, consumption, and mine reclamation.
- Name the possible effects of coal mining on water quality.
- Compare coal deposits and water use patterns in different parts of the U.S. to draw conclusions about potential coal-water problem areas.

TARGET AUDIENCE

Students of Chemistry, Earth Science, Environmental Science

TIME ALLOTMENT

Two to three class periods (Lab activity should continue at least three days, but need not take the entire period each day.)

MATERIALS

Student Handout 17-1, "Water and the Coal Resource"
Student Handout 17-2, "Coal Slurry Laboratory"
Student Handout 17-3, "Coal: A Case Study in Water Quality"
Coal (substitute charcoal if coal is not available)
Water
Hammer
Clear glass or plastic container (one per group)
Screens
Filter paper (various grades)
Evaporation dishes
Large container for water
Newspaper
Graduated cylinder
Distillation apparatus (optional)

TEACHING STRATEGIES

Introduce the topic by discussing the importance of coal as an energy resource. Your students may already know that coal is by far the greatest fossil fuel resource in the United States. You might ask the class about the advantages and disadvantages of increased coal use and list them on the board. Advantages: available; relatively low cost; allows more energy independence. Disadvantages: air and water pollution problems; land disturbance; increased demands for water.

Help students distinguish between two types of water use: withdrawal and consumption. Water withdrawal means simply that water is removed from the ground or diverted from a surface-water source for use. Water consumption refers to water that is no longer available because it has been evaporated to the atmosphere, incorporated into products or crops, consumed by people or livestock, or otherwise removed from the immediate water environment.

Now distribute Student Handout 17-1, "Water and the Coal Resource." Have students read the introduction and look at the data table. Discuss the questions with them in class.

Answers to Student Handout 17-1

1. Power generation.
2. Coal slurry: water travels from source and is no longer available for use. Mining: evaporates. Reclamation: becomes ground water.
3. Rail.
4. Power generation plant. There are several alternative cooling schemes (air cooling or cooling ponds, for example).
5. a) They would be built close to water resources instead of close to mines.
   b) Slurry pipelines would be much less feasible.
   c) Coal would be shipped closer to place of use, rather than at mine, if water situation were better.
6. Power generation, according to the table.

Next, proceed to the laboratory activity. Before beginning this activity with the class, use a hammer to break up the coal into fairly small pieces. Work on newspaper. Pour all pieces, large and small, into a container of water. Mix well. This should produce a material that resembles what is found in a coal slurry pipeline. Now distribute Student Handout 17-2 "Coal Slurry Laboratory," and divide the class into groups of four or less. Give each group the same volume of the coal-water mixture, and go through the lab procedure with them. Have on hand the suggested materials, and let each group plan its own method of attack. Most will begin by filtering. From this point strategies may vary, but students are likely to try settling, evaporation, additional filtering, and/or distillation. Give students ample time over several days to complete the task. Make comparisons as noted on the student pages.

At the conclusion of the laboratory activity, discuss the following questions:

1. What was your major difficulty? (Separating the smallest particles of coal from the water.)
2. What difference does it make at the end of a coal slurry pipeline if the fine particles cannot be separated out? (Limits the future uses of that water; loses some of the fuel value of the coal that was put into the pipeline.)
3. At what step(s) in your procedure was water lost and how could you have prevented those losses? (Answers will vary.)
4. Besides the presence of coal particles, how would you determine whether or not water quality had been affected in other ways by making the coal slurry?
5. What have you learned about coal slurry pipelines through this activity? (A coal slurry pipeline requires significant amounts of water; it is difficult to separate all of the coal from the water at the end of the pipeline; and water quality is affected by carrying coal with water.)

You may conclude this activity by listing the advantages and disadvantages of coal slurry pipelines with the class. Advantages: causes less air and noise pollution because it is built underground; makes possible more direct routing over difficult terrain; less expensive than rail; useful if rail could not handle coal. Disadvantages: large water requirements at mine; usually service limited to one point of origin and one destination; effluent problems at destination; coal must be processed at both ends of the line.

Next, distribute Student Handout 17-3, "Coal: A Case Study in Water Quality." Let students read the case study on surface mining and water, and look at the map of coal resources, the chart on water problem areas, and the map of coal slurry pipelines. To complete the lesson, students should write an essay covering the points listed on their summary sheets. (If you do not wish to use the essay format, simply change the essay points into individual questions for the students.)

As you evaluate the essays, look for coverage of all the points in a manner consistent with the data students have read. Some of the specific points are listed below.

Water is used in mining for control dust and clean coal. It is used in slurry pipelines; it is used to reclaim land; and it is used in power plants in which coal is burned.

The greatest quantities of water are used in slurry pipelines and in coal burning power plants.

Water quality can be a major problem at mine site. Acids, alkalis, suspended and dissolved particles and metals can pollute water draining from the site. Mining can interfere with water tables and aquifers.

Water allocations in the lower Colorado and Rio Grande basins will have to be planned carefully because the coal resources in these areas are much greater than the amount of water available for use in resource production.

Possible solutions include more efficient use of water, use of coal to generate electricity away from areas of high competition for water, and transport of water from other basins into areas where it will be needed for coal development.

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Student Handout 17-1
Water and the Coal Resource

Coal mining, processing, and consumption cannot take place without water. At the mine, water is used to suppress dust and to reclaim farmland after strip mining. Coal is washed with water to remove impurities like ash and sulfur. Coal can be transported by water: it is pulverized, mixed with water, and pumped through a coal slurry pipeline over great distances. At its destination, the coal must, of course, be dewatered and dried before it can be burned.

None of these processes, however, takes as much water as a conventional electric power plant. There the coal is burned to heat water and produce steam by which electricity is generated. Large amounts of water are needed to cool the steam.

Use the table to answer the questions below.

1. The water requirements listed in the table are actually amounts of water withdrawal. In which process(es) is little of the water withdrawn likely to be consumed?
2. In which process(es) is much of the water likely to be consumed?
3. Besides slurry pipeline, what other major means are used to transport coal from western sites?
4. In which process do the water quality problems seem most costly to fix?
5. If water resources are more scarce in the West, Southwest, and Midwest, how will that influence
   a) location of power generating plants?
   b) transportation of coal from the mine?
   c) location of coal cleaning facilities?
6. In which process do the potential savings in water use seem greatest?

Water Requirements in Coal Development and Use

Process	Requirements (gal. million Btu)	Water Use	Quality Problems
Western coal Mining	[illegible]	[illegible]	[illegible]
Surface Mine Reclamation	[illegible]	[illegible]	[illegible]
Eastern coal Mining	[illegible]	[illegible]	[illegible]
Coal Slurry Pipe	[illegible]	[illegible]	[illegible]
Power Generation	[illegible]	[illegible]	[illegible]

[illegible]

Source: [illegible] *Environmental Data for Energy Technology Policy Analysis*, Vol. I: Summaries. Mitre Corporation, Jan. 1974.

Student Handout 17-2
Coal Slurry Laboratory

The problem of transporting coal from the mine to its destination is becoming increasingly important. Advocates of coal slurry pipelines say pipelines are needed for two reasons: the railroad may not be able to handle the increase in western coal traffic predicted for the future; and the cost of transportation by slurry may be significantly lower. To prepare the coal for slurry transport, the coal is crushed at the mine, water is added, and the coal and water mixture is pumped through the pipeline to its destination.

Although this method of transportation is efficient and may be cheaper than rail, the pipelines require enormous amounts of water at the point of shipment—a key problem in arid western coal fields. It is estimated that about one ton of water is needed for each ton of coal moved. A pipeline moving 25 million tons of coal annually requires about 19,000 acre - feet of water per year at its source. (An acre - foot is 1,233,581 liters, or 325,613 gal.) Disposing of the pipeline effluent at the end of the line is also a problem.

In this laboratory activity you will investigate the problems of a coal slurry pipeline. Specifically, you must separate the coal from the water to make the water as clean as possible.

1. Get the coal slurry mixture from your teacher.
2. Measure its total volume.
3. Using the materials made available to you, separate as much coal from the water as you are able.
4. Be sure to record each strategy you undertake. For each one, note steps you take, the time used, any energy input outside of yourselves, and any comments you care to make on the process.
5. Save *all* water and coal. Do not dispose of any amount of either.
6. When finished, compute your results with other groups in class in these ways: color of water remaining, amount of water saved (withdrawn, but not consumed), time and minimum energy input.
7. When all of the above has been completed, add the coal back to the water and measure its total volume again. Subtract from the original volume to calculate how much water has been consumed.

Student Handout 17-3
Coal: A Case Study in Water Quality

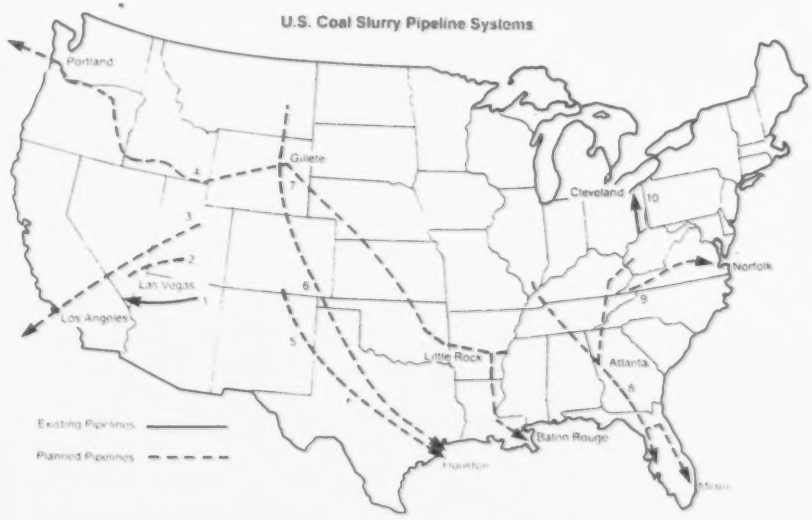
Many strippable coal beds in the West are near or under the surface drainage channels and underground waterways of permeable rock called aquifers. Underground and surface mining of their coal could have serious impacts, significantly disrupting the West's fragile hydrologic system and causing serious secondary effects.

During surface mining, for instance, natural drainage channels are often diverted to facilitate coal extraction. Diversion channels are usually constructed of easily erodable soil and, during heavy rains, streams and waterways are often polluted by the channels' erosion, affecting both plant and fish life. In addition, underground mining can contaminate usable aquifers that support human, animal, and plant life with salts and other minerals. In many cases, there is no alternative source of water, so an already limited ground water supply is further reduced.

Of special interest in the West is the preservation of alluvial valley floors, that is, downstream valleys fed by or near surface streams. These valleys are the productive basis for agriculture and cattle ranching in the West. Mining in or near these areas can disrupt drainage patterns, water flow, crops the following

Pipeline System	Length (Miles)	Annual Capacity (tons)
1. Black Mesa	273	4,500,000
2. Slim Buttes/Belle Fourche	144	11,000,000
3. Powder River	660	10,500,000
4. Salt Lake	1,130	25,000,000
5. San Juan	465	10,000,000
6. Twin Buttes	1,060	22,000,000
7. El Paso	1,662	28,000,000
8. Cadiz-Vidal	1,550	28,000,000
9. Valley	190	5,000,000
10. Ohio	170	4,000,000

U.S. Coal Slurry Pipeline Systems



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the alluvial floors and reduces the valley's productivity. Surface mining legislation is needed to help protect these valleys. (1)

The case study below will give you specific ideas on the water problems in an area near a particular strip mine. Although the names have been changed, they are actual cases.

Blue Valley Coal Mine has attempted to keep all the water it uses on the mine site instead of discharging it. To accomplish this task, Blue Valley has built holding ponds from which the water is allowed to evaporate. The water also is sprayed on dusty roads. There have been some problems with the ponds. For example, one pond was contaminated and discharged onto land around the mine site, and a ditch once discharged directly into Azure Creek. These problems are being corrected.

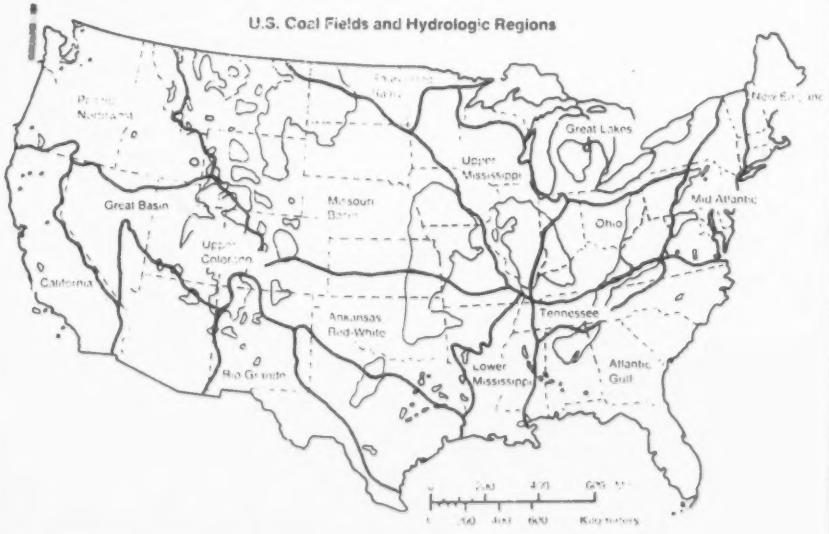
Azure Creek has come under some scrutiny because at one time it was a seasonal watercourse, only flowing at certain times of the year. It now flows year-round. Area residents believe that the mine's holding ponds, a water pond for cooling the coal power plant, and a new sewage system nearby have caused this change.

On a nearby ranch, the Appel family blames its loss of high quality well water on leakage from Blue Valley's mine site into Raven Creek, which feeds the family's ground water supply. Their well water has become dark [illegible] and cross-like. They have had to drill a new well, and have filed suit against Blue Valley Mine.

The company has been cited for being insensitive to the groundwater needs of local ranchers. For example, there is a 25-foot coal seam considered by residents and the Bureau of Land Management to be a critical local aquifer for households and livestock. However, Blue Valley has said that the coal seam is "very disrupted and an unreliable groundwater source. It has little economic importance since its use is only supplemental." This coal seam runs through the mine site. Replacement of portions of this seam with spoils (mining leftovers such as shale, clay, and sand) has altered the water paths in, and fields north of the mine have been flooded by rising water tables.

Finally, Blue Valley has been warned that the overburden ties are grading in reclaimed areas is extremely salty. This work could also affect groundwater quality. (2)

Source: C.E. Gizzo, "Issue in Brief: The Case for Coal-Slurry Pipelines," National Coal Association



Regional Runoff and Consumptive Statistics for 1975*

Region	Mean Runoff (billion cubic feet per year)	Consumptive Use (billion gallons per day)	Per Capita Runoff (gallons per day)	Consumptive Use as a Percentage of Mean Annual Runoff
New England	[illegible]	0.46	6.6	[illegible]
Mid-Atlantic	[illegible]	1.76	2.43	[illegible]
South Atlantic Gulf	[illegible]	4.13	5.26	[illegible]
Great Lakes	84.9	1.22	3.65	0.258
Ohio	142.7	1.99	6.48	0.21
Tennessee	80.2	0.82	14.77	0.020
Upper Mississippi	72.9	1.65	8.73	0.314
Lower Mississippi	3.5	0.16	1.77	0.768
Souris-Red-Rainy	7.5	0.14	9.75	0.310
Missouri	69.3	10.44	6.85	0.32
Arkansas	31.5	1.56	12.96	0.10
Texas Gulf	33.6	1.33	3.40	0.65
Rio Grande	3.6	1.86	2.84	0.87
Upper Colorado	14.6	2.73	32.45	0.39
Lower Colorado	3.6	3.10	1.35	2.3
Great Basin	5	4.46	5.67	0.55
Pacific Northwest	234.9	14.56	35.64	0.062
California	69.7	27.54	3.32	0.40
Alaska	648.0	0.0362	1620.00	9.6 × 10⁻⁶
Hawaii	14.6	0.62	17.82	0.043
United States	2021.5	122.31	8.91	0.060
United States excluding Alaska and Hawaii	1338.9	121.50	6.32	0.091

* Totals may not add due to rounding (p. 199 CONAES Report)

Source: *Energy in Transition 1985–2010*, Final Report of the Committee on Nuclear and Alternative Energy Systems, National Academy of Sciences, 1979

Using what you have learned about coal and water, look over the preceding maps and tables and write an essay that covers the following points:

- Ways in which water is used in all phases of coal development from mining to burning.
- The point(s) at which the greatest quantities of water are required in coal development and use.
- How and where in the process of coal production water quality is a problem.
- Which areas of the United States will have to plan their coal development and water resource allocations carefully, given increased coal development in this country.
- Some suggestions for minimizing water quantity and quality problems associated with coal.

Remember to support your statements.

Notes

1. *U.S. Coal Development—Promise, Uncertainties*, Report to Congress, Comptroller General of the United States, September, 1977.
2. D.P. Wiener, *Reclaiming the West*, New York: INFORM Books, 1980.

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OTHER USEFUL INSTRUCTIONAL AND BACKGROUND MATERIALS

CURRICULUM MATERIALS

ECONOMICS OF ENERGY by Joint Council on Economic Education. 1982.
Available from: Joint Council on Economic Education, 2 Park Ave., New York, NY 10016. $8.50.

This is a collection of eleven activities for students in grades 7-12. Using a variety of teaching techniques, the activities provide basic lessons in supply and demand, costs and pricing, markets, and scarcity.

Many of the activities are excellent, although a few are only appropriate to upper grade students studying economics. Could be used to reinforce basic economics concepts while providing important instruction about energy uses and supply.

ELECTRICITY: TODAY'S TECHNOLOGIES, TOMORROW'S ALTERNATIVES by Electric Power Research Institute (Third Edition). 1986.
Available from: Innovative Communications, 2923 N. Main St., Walnut Creek, CA 94596. $9.95.

This student reading book covers all aspects of electricity generation and transmission. Articles cover load management, environmental concerns associated with generation, and future generation options.

Teacher's guide includes comprehension questions for each unit and lists sources of additional information.

ENERGY ACTIVITIES FOR HOME ECONOMICS by Audrey Grate. 1981.
Available from: Home Economics Supervisor, Minnesota State Dept. of Education, Capitol Square, 550 Cedar St., St. Paul, MN 55101. Free.

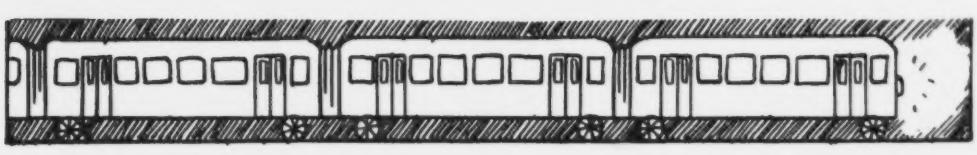
This looseleaf, teacher resource, for grades 7-12, uses an open ended, problem solving approach, and emphasis is on decision making process. The instructional methods used are discussions, experiments, role playing, menu planning, and sewing projects.

Eleven activities covering conservation, energy use and energy choices. Included is an excellent paper highlighting the developmental needs of the middle school youngster and a rationale for developing home economics curriculum at that level. Resources are suggested for most activities. Experience in home economics required.

ENERGY ACTIVITIES FOR INDUSTRIAL ARTS by D. Thomas Ryerson. 1981.
Available from: Industrial Education Supervisor, Minnesota Dept. of Education, Capitol Square, St. Paul, MN 55101. Free.

This looseleaf material, for grades 7-12, is a hands-on approach with 12 activities involving students in energy related projects, utilizing constructions, comparison tests, and drawings.

These unusual activities focus on different areas of industrial arts: wood, metal, drafting, electronics, etc. Topics covered are: solar collectors; greenhouses; temperature sensing; gasohol; conservation; insulation; recycling; Savonius motors; and pedal power. Resources are listed for some activities. Experience in industrial arts required.



ENERGY ACTIVITIES FOR THE CLASSROOM, VOL. II by Herbert L. Coon and M. Alexander. 1978.

Available from: ERIC Clearinghouse for Science, Math & Environmental Education, College of Education, Ohio State University, 1200 Chambers Rd., 3rd Floor, Columbus, OH 43212.

This 148 page book, for grades K-12, emphasizes energy activities for science. It contains activities, divided by grade and subject, that have been arranged around a stated concept. It includes discussions, demonstrations, research, and simple lab experiments.

Collection is uneven, it contains several good ideas. Activities are all suggested by teachers. Could be used as infusion activities for existing programs. Requires support information.

ENERGY AND ECONOMICS by Joyce Gleason and William Walstead. 1983.

Available from: Center for Economic Education, 305 College of Business Administration, University of Nebraska — Lincoln, NE 68588-0402. $5.00.

This collection of 12 activities for grades 10-12 deals with economic principles and energy issues. Activities cover scarcity, opportunity cost, cartels, pricing, and equilibrium. Teaching strategies emphasize games and worksheets.

The activities can be used together as a unit that takes two to three weeks, or each activity can be used separately. To be used as part of an economics unit, the teacher will need to supply more economics materials and should be familiar with economics principles.

ENERGY EFFICIENT RESOURCE GUIDE FOR DRIVER EDUCATION by the Iowa Energy Policy Council. 1983.

Available from: Iowa Energy Policy Council, Capitol Complex, Des Moines, IA, 50319. Free.

This 74 page booklet is designed to help beginning drivers learn how to get the best gasoline mileage from their cars. The guide covers how vehicle selection, maintenance, and operation influence fuel use.

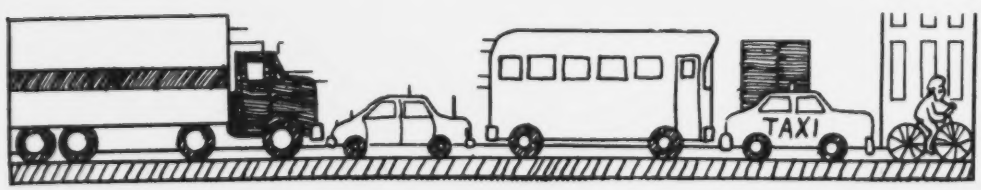
This is a unique booklet and covers a very large area of energy use that is often neglected. Guide contains learning aids, discussion topics, and sample examination questions. No previous background in energy-efficient transportation required.

ENERGY, ENVIRONMENTAL AND OUTDOOR EDUCATION ACTIVITIES by John C. Miller. 1980.

Available from: State of Minnesota, Department of Education, Elementary and Secondary Education, 644 Capital Sq. Bldg, St. Paul, MN 55101. Free.

This multidisciplinary teacher resource is a folder of hands-on activities, investigations, and demonstrations for outdoor education classes.

Material contains suggestions for outdoor activities to help develop 9 energy concepts: solar; energy resources; energy forms; diversity of sources; transfer of energy; energy measurement; conservation; dependence; cooperation. Some background information is given, and student outcomes are stated but some are unrealistic. Some familiarity with recreation activities is necessary.



ENERGY, FOOD, AND YOUR FUTURE by National Food and Energy Council. 1982.
Available from: National Food and Energy Council, 409 Vandiver West, Suite 602, Columbia, MO 65202. $15.00 for teachers guide.

This is a curriculum package dealing with the connections between energy use and food production. Much of the material is geared to energy use on a farm or in getting food to market. Package contains a series of readings with accompanying discussion topics, questions to check comprehension, and suggested projects.

The package includes many, well prepared charts and graphs on the energy use by the food system. This curriculum is of greatest value to teachers of agriculture classes or students from farming families. Users should also have access to more detailed information on energy sources.

ENERGY REPORTER by the Electric Power Research Institute, 1981-1982.
Available from: Innovative Communications, 2923 N. Main St., Walnut Creek, CA 94596. $7.50/classroom set.

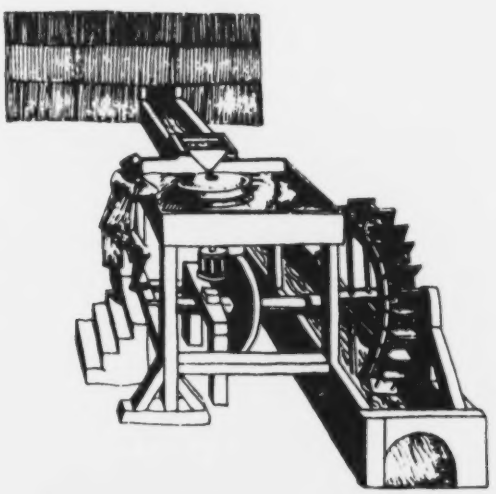
Each four page pamphlet provides current information on technologies related to electricity generation. Current topics include coal, conservation, electricity overview, electric vehicles, fuel cells, geothermal energy, hydroelectric power, nuclear fission and fusion, solar electricity, solar heating and cooling, wind power, and transmission and distribution of electricity.

Each pamphlet is well designed and field tested in high school classrooms. They can easily be used for short topics or kept for classroom reference. Some pamphlets may no longer represent the current state of technological development.

ENERNOMICS by Innovative Communications, copyright 1983.
Available from: Innovative Communications, 2923 North Main St., Walnut Creek, CA 94596. $59.50/classroom set of 40.

This teaching unit combines an introduction to economic concepts with a problem solving focus on the home energy budget. Kit contains cartoon style information book, filmstrip, consumer tabloid, and fact sheets.

Teacher's guide outlines four implementation approaches. The kit takes between four and ten days to implement and can be used to introduce concepts like home budgetting and to develop skills such as interpreting charts.



KNOW NUKES: CONTROVERSY IN THE CLASSROOM by Mitch Thomashow. 1986.
Available from: D.C. Heath Company, 125 Spring St., Lexington, MA 02173. $19.95.

This eight chapter, 260 page book, covers all areas of the nuclear fuel cycle and the generation of electricity from nuclear powered plants. Topics include radiation, how reactors work, radiation and human health, low level radioactive waste disposal, nuclear power/nuclear weapons, and emergency planning.

It contains activities, teacher background information and suggestions for handling controversial topics in the classroom. The problems, challenges, and dilemmas presented help students formulate their own opinions.

LIVING LIGHTLY ON THE PLANET by Maura O'Connor. 1985.
Available from: Schlitz Audubon Center, 1111 East Brown Deer Road, Milwaukee, WI 53217. $12.00 volume plus $1.50 postage and handling.

This is a two volume (vol. 1 — grades 7-9, vol. 2 — grades 10-12) global environmental education curriculum guide. Activities focus on the environmental effects of energy and resource use.

An interesting collection of activities that concentrates on the association between lifestyle and resource use. Materials are useful in a variety of classes and includes references, discussion ideas, and instructions for demonstrations.

NATIONAL ENERGY FOUNDATION by National Energy Foundation
Copyright 1982.
Available from: National Energy Foundation, 5160 Wiley Post Way, Salt Lake City, Utah 84116

Approximately 100 lesson plans organized to educate students about the energy education goals of EME: sources of energy, uses of energy, conversion of energy from one form to another, impacts of energy development, limited nature of natural resources, future of energy sources, and energy conservation. The collection of core materials (available only through EME Implementation Program) has ideas for science, mathematics, social studies, language arts, and vocational education. Activities range from short, simple ideas to library research.

The strength of EME materials is the quantity of activities that can be easily infused into curriculum. Activities vary greatly in amount of teacher preparation necessary. Materials are best integrated into existing units rather than presented as a special energy unit.

PLAYING WITH ENERGY: CLASSROOM GAMES AND SIMULATIONS by National Science Teachers Association. Copyright 1981.
Available from: National Science Teachers Association, 1742 Connecticut Avenue, NW, Washington, D.C. 20009. $9.00.

This collection of five games and simulations is organized around energy themes for use in science classes. It provides materials in a ready-to-duplicate form for games dealing with energy supply and the consequences of energy use.

Games were created by teachers as part of the Project for an Energy Enriched Curriculum. Each includes guidelines, but some additional teacher research and preparation may be necessary.

PREPARING FOR TOMORROW'S WORLD by Institute for Science, Technology and Social Science Education. 1980-1982.

Available from: Sopris West, 1120 Delaware Ave., Longmont, CO 80501.

People and Environmental Changes — $80.00
Energy: Decisions for Today and Tomorrow — $70.00
Technology and Society: A Futuristic Perspective — $80.00
Environmental Dilemmas: Critical Decisions for Society — $85.00

These materials, for grades 9-12, are collections of simulation modules designed to improve students' ability at making decisions. One or more scenarios per volume deal with an energy related topic, usually as it applies to society. The instructional methods used include discussions, case studies, role playing, and decision making.

Many of the activities presented are excellent for use in social studies courses or in science classes that study the interactions between society, technology, and science. Teacher's guide includes sample discussion ideas and information in conducting simulations. Not all of the examples are related to energy concepts, and some of the exercises are based on events no longer newsworthy. Units require teachers interested in teaching about issues that have no right answers.

RENEWABLE ENERGY: A BACKGROUND TEXT by the Solar Energy Project. 1984.

Available from: Solar Energy Project, SUNY at Albany, 1400 Washington Ave., P.O. Box 22100, Albany, NY 12222. $15.00.

This secondary level text on renewable energy sources parallels the series of "**Renewable Energy Activities for . . .**" (see below) also produced by the Solar Energy Project.

Much of this text was prepared in the early 1980s and as a result some of the material may be out of date.

RENEWABLE ENERGY ACTIVITIES FOR . . . by The Solar Energy Project. 1984.

Available from: Solar Energy Project, SUNY at Albany, 1400 Washington Ave., Box 22100, Albany, NY 12222.

Renewable Energy Activities for Biology — $2.75
. . . for Junior/Middle School — $4.25
. . . for Earth Science — $3.50
. . . for General Science — $3.50
. . . for Chemistry and Physics — $2.75

This collection of materials is a reprint of materials first developed in 1980. The activities involve energy topics while reinforcing concepts already a part of the respective science curricula. Some of the activities also are included in the booklets of the New York Energy Education Project (see page 51).

Each book is a collection of at least five activities, all of high educational value. Each activity clearly states objectives and skills and includes student and teacher pages as well as points for discussion and further investigation. Some of the references are out of date.

SAVINGS THROUGH ENERGY MANAGEMENT by Wilson Education Associates. 1986.
Available from: Wilson Educational Associates, 60 Creamery Road, Cheshire, CT 06410. Contact them for current price.

This award-winning program instructs high school students in energy management for commercial buildings. Students learn the principles of energy loss and conduct a comprehensive energy audit of their school. After the audit, students present their findings and recommendations to the building managers. Participating schools usually average energy savings over $20,000/year as a result.

The training program is operated by staff of Wilson Education Associates at the participating school. Program involves 30 hours of classroom instruction with follow-up assistance as needed when the students are conducting the audit. Program best suited for students in grades 9-11.

SCIENCE ACTIVITIES IN ENERGY by Oak Ridge Universities. 1977.
Available from: U.S. Dept. of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830. Free.

This material for grades 5-9, consists of seven file folders, each with 11-16 activity sheets. Some activities have teacher's guide. The time needed for the activities varies but all foster open ended exploration and are designed for infusion into existing science courses. They provide information, investigations, demonstrations and questions.

Well designed, attractively presented packets of activities on various energy topics, Biomass, Conservation I and II, Electric, Chemical, Wind, Energy Storage. Each activity sheet begins with a question and graphically directs the inquiry to its conclusion. Additional ideas are included for further exploration and the experiments require easy to obtain supplies. Assumed energy background varies, however, elementary physical science is needed to explain the "why" of the concepts encountered. Some experiments should be closely supervised. (Note: Solar I & II may be available again but at present are unavailable.)

TEACHING ENERGY AWARENESS by Patrick D. Gare & John Masoncup. 1980 revision, copyright 1978.
Available from: Center for Teaching International Relations, University of Denver, Colorado 80208. $14.95 plus $2.00 postage.

This book is a teacher resource appropriate for grades 5-12, emphasizing science/social studies activities but also economics and home economics. The materials use the instructional strategies of involvement, discussion, data gathering, using community resources, and questioning.

A good source of teaching activities that compliments an existing course of study while creating an awareness of and interest in energy issues. The activities are interesting, "do-able" and require few extra materials. Almost half of the book is hand-outs and information to support the activities.

ENERGY EDUCATION MATERIALS FROM ERIC

Many energy education materials are available through the Educational Resources Information Center (ERIC) of the National Institute of Education. Often these are materials produced by teachers but never printed or distributed, or are copies of materials once circulated that are now unavailable. Microfiche copies are available at many large libraries. Request materials by the access number.

ERIC receives many materials and generally does not evaluate them. Many older (circa 1980 or earlier) energy education materials may be included in the ERIC holdings and may provide teachers with worthwhile instructional ideas if the data were replaced with more current information. The list below is representative of energy education materials recently added to the ERIC collection. The materials on the list have not been evaluated by the Energy Education Program for content or usability in a classroom, nor is the list intended to be comprehensive. The information is provided as a starting-point for teachers who may be looking for lesson ideas. Each item provides the document access number, thereby saving teachers the effort of searching for documents by identifying words. For more information about ERIC, consult a librarian on the staff of a library that receives ERIC materials.

Materials listed in ERIC

Hardee County Energy Education Lessons 1982-1983: Teacher Produced Lessons in Energy for Vo-Tec, Science, English, and Social Studies Classes (ED 232 871).

Energy and the Family:

Home Management (ED 236 396); Consumer Education (ED 236 397); Food and Nutrition (ED 236 398); Textiles and Clothing (ED 236 399); Housing and Home Furnishing (ED 236 400)

Desolate Desert Controversy: Should Presto Power Company Build a Nuclear Power Plant? Instructor's Guide and Student Materials, a Business-in-the-Classroom Lesson Plan (ED 238 817).

Crossroads: Quality of Life in a Nuclear World

A High School English Curriculum (ED 240 044).
A High School Science Curriculum (ED 240 045).
A High School Social Studies Curriculum (ED 240 046).

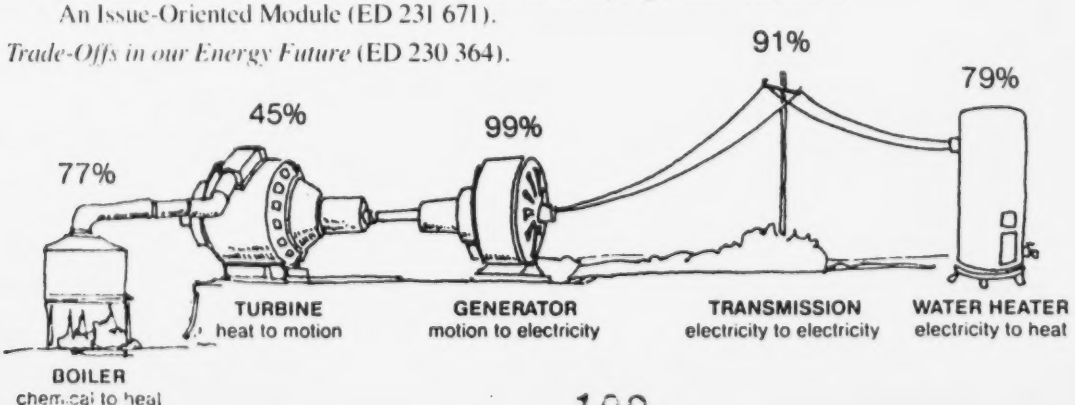
Energy and Transportation Lessons for Senior High Grades (ED 250 191).

Competency Based Education Curriculum for Energy Efficient Building Construction (ED 229 611).

Prepared by American Association of Physics Teachers:

Solar Thermal Power (ED 231 667)
Sunburn and Sunscreens (ED 231 668)
Thermodynamic Efficiency: An Issue-Oriented Module (ED 231 669)
Geothermal Energy: Resource and Utilization, A Teaching Module (ED 231 670)
Introduction to Nuclear Fusion Power and the Design of Fusion Reactors, An Issue-Oriented Module (ED 231 671).

Trade-Offs in our Energy Future (ED 230 364).



BACKGROUND INFORMATION FOR TEACHERS AND STUDENTS

This section lists books of value to educators who teach about energy and its role in society. The number of books published about energy sources and technologies is overwhelming. This list, of course, cannot begin to be comprehensive, or even representative. Instead, books are included because they meet one or more criteria:

- books of value to teachers who wish to increase their understanding of energy sources and uses without an exhaustive amount of research
- books of value because they contain current data on energy supply and use
- and/or books from unusual sources which might be overlooked by public or school libraries.

Students researching energy topics should have no problem finding information on energy supply and use in libraries.

ENERGY AND EDUCATION: TEACHING ALTERNATIVES by Frederick E. Rosthurnas (Ed). Copyright 1978.
Available from: National Education Assoc., The Academic Bldg, Saw Mill Road, West Haven, Connecticut 06516 $8.95.

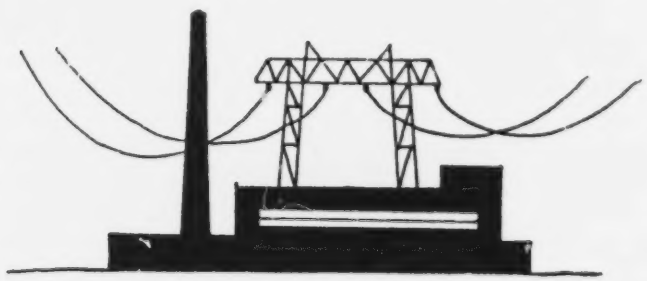
This book is an informational text, including discussions, and research with an emphasis on science and social studies.

It contains some interesting lessons grouped into mini-units. Strength of book is presentation of the need for energy education. However, the text, statistics, references and figures are outdated.

ENERGY-ENVIRONMENT SOURCE BOOK by John M. Fowler. Copyright 1980.
Available from: NSTA, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009. $9.00 plus $2.00 postage and handling.

This book is intended to provide teacher with adult level energy information.

This reference work gives teachers authoritative information on the issues, problems, and the facts of energy. Profusely illustrated with charts and tables which require updating, it includes a glossary and appendices with technical information. A valuable reference source.



ENERGY AND ENVIRONMENT by John Fowler, 2nd Edition, Copyright 1984.
Available from: McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020. $22.95.

This is a college text on energy issues and is appropriate for teacher reference and advanced high school students.

This book completely covers the study of energy, from what energy is to the political and social implications of its use.

ENERGY FACTS 1984 by Energy Information Administration. 1985.
Available from: National Energy Information Center, EI-20, Energy Information Administration, U.S. Department of Energy, Washington, D.C. 20585. Free.

This is a short booklet summarizing energy use in the United States from 1960 through 1984 useful as a reference source.

It includes charts and tables dealing with U.S. petroleum, natural gas, coal, and electricity use. A valuable resource for teaching data interpretation.

STATE ENERGY DATA REPORT by the Energy Information Administration. 1986.
Available from: National Energy Information Center, EI-20, Energy Information Administration, U.S. Department of Energy, Washington, D.C. 20585.

This reference work is published annually and is suitable as for use in advanced coursework and student projects.

It is the authoritative source of energy use in the United States and includes tables of historical data for both the United States and each of the fifty states. May be found in U.S. government documents depository libraries.

STATE OF THE WORLD 1986 by Lester R. Brown and the staff of the Worldwatch Institute. 1986.
Available from: W.W. Norton and Co., 500 Fifth Avenue, New York, NY 10110. $8.95.

This is a good book for teachers and students investigating global resource use. It is particularly valuable because it provides recent global data in a very accessible form.

This is the third in a yearly series of books examining the worldwide progress towards achieving a sustainable society. Using a broad network of informational sources, the report monitors changes in the global resource base (land, water, energy, and biological support systems) focusing particularly on how changes there affect the economy. Each volume of the past three years covers slightly different subjects.

SUN UP TO SUN DOWN by Shawn Buckley. Copyright 1979.
Available from: McGraw Hill Publishers. $6.95.

This book for grades 7-9 emphasizes industrial arts through informational text and definitive illustrations.

Explains how solar technologies for heating work. A section on solar economics is concise and to the point. Useful only if trying to explain to students how devices work, as it offers analogies that students might understand. May be too advanced for many students.

WORLDWATCH PAPERS by Worldwatch Institute.
Available from: Worldwatch Institute, 1776 Massachusetts Avenue, N.W., Washington, D.C. 20036. $4.00/copy bulk rate. $25.00 year subscription.

These booklets offer informational text, in a variety of disciplinary areas.

Worldwatch Institute publications cover global economic and environmental concerns. Their "Papers" series range in length from 22 pages to 83 pages and, to date, the 61 titles include 17 directly related to energy. They are an excellent, inexpensive, and accurate source of information. Send for list of publications.

PERIODICALS

Periodicals are invaluable caches of timely information and should be considered in any energy-related investigation. To find articles, consult the *Readers Guide to Periodical Literature* or *The Applied Science and Technology Index* for magazine articles and the appropriate newspaper index that covers the newspapers of interest.

Members of the NEED network (Page 47) receive a list of recent energy articles covering all energy topics as part of their annual participation kit.

Alternative Sources of Energy.

Each issue contains a wide spectrum of practical information concerned with the development of alternative technologies in energy sources, agriculture, architecture, transportation and communication.

Publisher: *Alternate Sources of Energy*
107 S. Central Ave.
Milaca, MN 56353
$25/year - bimonthly

Country Journal.

Many good articles on energy use related to gardening, agriculture, fuels and forests, architecture, transportation, electric power, health, waste disposal and conservation.

Publisher: *Country Journal Publishing Co., Inc.*
P.O. Box 2402
Boulder, CO 80321
$15/year

Energy and Education Newsletter.

A bi-monthly newsletter features editorials by energy professionals, listings of free and inexpensive materials, book reviews, current data on the energy situation, and news from energy educators.

Publisher: *N.S.T.A.*
1742 Connecticut Ave., N.W.
Washington, D.C. 20009
$9/year

Environment.

Food and famine, health and disease, energy and conservation, pollution, waste — facts of our environment — are all given meaningful reporting in this publication.

Publisher: *Heldief Publications*
4000 Albemarle St., N.W.
Washington, D.C. 20016
$20/year

Environmental Action.

Major coverage of environmental quality issues including energy.

Publisher: *Environmental Action*
1346 Connecticut Ave., N.W.
Suite 731
Washington, D.C. 20036
$18/year

Environmental Education Report.

An excellent publication covering all aspects of environmental education. Includes good book and material reviews.

Publisher: *American Society for Environmental Education*
Wheeler Professional Park
P.O. Box 800
Hanover, NH 03755

$25/year

National Geographic.

Excellent coverage of energy development is provided in one or two articles each year.

Publisher: *National Geographic Society*
17th and M Streets N.W.
Washington, D.C. 20036

$15/year

Natural History.

An excellent publication primarily dealing with animal or plant topics but occasionally publishing articles on the historic importance of energy use.

Publisher: *American Museum of Natural History*
Central Park West at 79th St.
New York, NY 10024

$20.00/year

New Alchemy Institute.

A subscription membership includes current journal and newsletters. The Institute is concerned with the development of ecologically sound forms of energy, agriculture, aquaculture and housing. A good source for alternative energy information.

Publisher: *The New Alchemy Institute*
237 Hatchville Rd.
East Falmouth, MA 02536

$35/year

New England Builder.

A monthly magazine primarily for housing contractors that includes articles on the state of the art in energy efficient design. Especially of value to students and teachers in trade programs.

Publisher: *New England Builder*
P.O. Box 278
Montpelier, VT 05602

$12/year

New Shelter.

A monthly magazine of interest to homeowners. Many articles deal with new developments in residential energy use and conservation.

Publisher: *Rodale Press*
33 E. Minor St.
Emmaus, PA 18049

$11/year

Northeast Sun.

A quarterly magazine covering energy use and issues in the northeast. Biased towards renewable energy development.

Publisher: *New England Solar Energy Association*
14 Green St.
Brattleboro, VT 05301

$25/year

Not Man Apart.

Presents excellent articles on people learning to live in their environment. Much earth and energy news, good reading lists and reviews in each issue.

Publisher: *Friends of the Earth Foundation*
1045 Sansome St.
San Francisco, CA 94111

$15/year

Science.

Weekly magazine published by the AAAS, should be checked regularly by teachers. Many bits of information can be obtained from the sections "Research News", "News and Comments", letters and editorials. Many of the articles could be assembled for class readings or research references for advanced students.

Publisher: *American Association for the Advancement of Science*
1515 Massachusetts Ave., N.W.
Washington, D.C. 20005

$50/year

Scientific American.

Monthly periodical covering all aspects of science.

Publisher: *Scientific American*
P.O. Box 5919
New York, NY 10017

$24/year

Smithsonian.

This publication has frequent articles on natural resources and energy use providing good commentary on man's technology in nature's environment.

Publisher: *Smithsonian Associates*
P.O. Box 2953
Boulder, CO 80321

$18/year

Solar Age.

A monthly magazine devoted to developments in renewable energy use. Considered the "journal of record" by many solar energy experts.

Publisher: *Solar Vision*
Church Hill
Harrisville, NH 03450

$32/year

AUDIO-VISUAL MATERIALS

This is a brief list of energy related films, filmstrips and video cassettes. They are recent releases or films worth considering from small distributors and of high quality. A more complete list is available in Movies About Energy listed with the addresses of American Petroleum Institute. The local utility serving your school may have additional offerings. Previewing films before renting is encouraged.

As If People Mattered: E.F. Schumacher

Bitteroot Films. 1979. 16mm color. 16 mins. Grades 7-adult. A summary of Schumacher's economic arguments with special reference to the world energy situation. It emphasizes the need for practical alternatives. Distributed by Bullfrog Films.

The Ecology of the Automobile in Modern Society — Its Present and Future

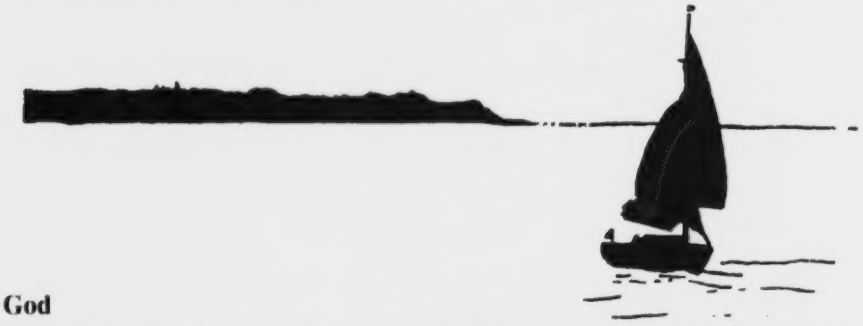
Educational Images. 3 Filmstrips, teaching guide, cassette. Examines the relationship of the automobile to modern Society from a biological approach, assesses its impacts, benefits and costs, and suggests how its role must evolve if it and society are to survive.

The Four Corners: A National Sacrifice Area?

Christopher McLeod, Glenn Switkes, and Randy Hayes. 1983. 16mm color. 58 mins. Grades 9-adult. An award winning documentary that reveals the hidden costs of energy development in Utah, Colorado, New Mexico, and Arizona. Film brings home the powerful conflicts that surround energy development in the Southwest. Distributed by Bullfrog Films.

Lovins on the Soft Path: An Energy Future With a Future

Envision Corporation. 1982. 16mm color. 36 mins. Grade 9-adult. A summary of the "soft energy path" that emphasizes efficient use of energy as a basis for energy planning. It includes a study guide to help teachers use the film to generate discussion. Distributed by Bullfrog Films.



No Act of God

National Film Board of Canada. 16mm color. 28 mins. Grades 7-adult. This film about nuclear power focuses on the central issues: lack of safe waste disposal system, threat of terrorist activity, and the loss of personal freedoms combined with the worldwide proliferation of plutonium for weapons that must characterize a society dependent on nuclear power. Distributed by Bullfrog Films.

Power Without End

Guidance Association. Video cassette. 16 mins. Grades 6-10. The sun, wind, geothermal, water and tides are alternative sources of energy examined in this program, as are methods of conservation.

Switch on the Sun

Guidance Association. Video cassette. 15 mins. Grades 6-10. This production explores ways we can harness solar energy and put it to use as a safe practical alternative to fossil fuels.

Toast

Earth Chronicles. 16mm. and video cassettes. 12 mins. Grades 3-adult. Starting at the oil-well and ending at the toaster, this film traces the energy intensive process, that is involved in bringing a slice of toast to the table. The accompanying study guide explains the concept of net energy profit. Distributed by Bullfrog Films.

We've Got the Power

American Friends. 140 slides or 2 filmstrips and cassettes. 26 mins. Grades 7 to adult. A discussion-provoking presentation on the choice we must make; whether to rely on nuclear power and fossil fuels or switch to renewable energy sources and practical conservation. Documents some local achievements (Franklin County, Mass.) and shows how people can work together for a safe energy future. Distributed by Bulldog Films.

The World of Energy

I - 1979 and II - 1982. National Geographic filmstrips and cassettes. 14 to 17 mins. Grades 5-12. $79.95.

I - focuses on traditional energy sources; wind water and fossil fuels, energy use, and conservation.

II - looks at energy sources, their use, conservation, and different aspects of our energy problem. Examines nuclear energy, its advantages and disadvantages, and alternative energy sources.

The addresses for the proceeding film distributors and other usually reliable sources of audio-visual aids are listed below. Send for catalogs containing current rental and sale price information and a complete list of materials offered.

Bullfrog Films
Oley, PA 19547

The Center for Humanities
Communications Park
P.O. Box 1000
Mt. Kisco, NY 10549

Disney Films
11 Quine St.
Cranford, NJ 07016-3197

Educational Images
P.O. Box 367
Lyons Fall, NY 13368

Encyclopedia Brittanica
Educational Corp.
425 North Michigan Avenue
Chicago, IL 60611

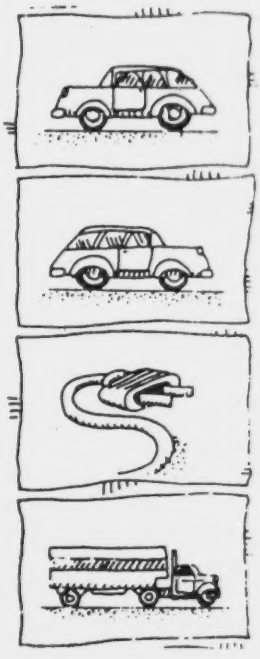
Guidance Associates
Communications Park
P.O. Box 3000
Mt. Kisco, NY 10549

Modern Talking Picture Service
5000 Park Street North
St. Petersburg, FL 33709
Ask for "Science, Energy and the Environment."

National Geographic Society
Educational Services
Washington, D.C. 20036

National Film Board of Canada
16th Floor
1251 Avenue of the Americas
New York, NY 10020

American Petroleum Institute
Public Relations Department
Photographic & Film Services
1220 L St., N.W.
Washington, D.C. 20005
Publishes Movies about Energy, a catalog of more than 1000. energy films.



COMPUTER SOFTWARE

Since 1983, almost every educational school supplier has included a few computer programs in their catalogs. Because both quality and educational value of the programs vary greatly, it is important that you use caution in purchasing them. Before buying, try to find someone who has used the program or preview it yourself, if possible.

The following are two examples of available energy software packages.

Available From:
Alabama Dept. of Economic and Community Affairs
3465 Norman Bridge Road
P.O. Box 2939
Montgomery, Alabama 36105-0939
Attn: Mrs. Donna Robinson

Each of the following include a disk and teacher guide. $20.00 each.

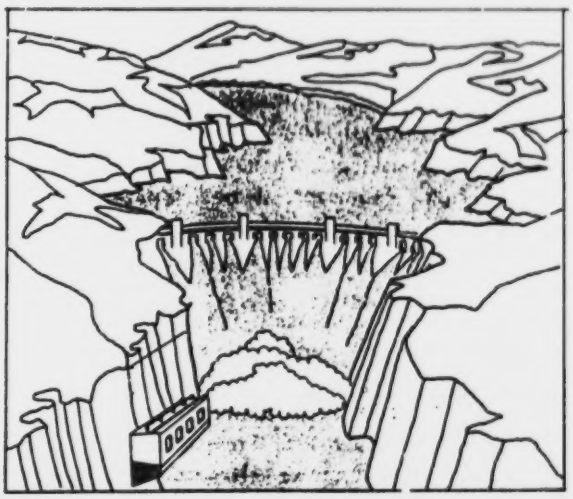
Energy Crossword
Apple II and IIe, grades 7-12. Energy terms used in crossword puzzles. Includes crossword maker which allows teacher/student to input their own puzzles.

Energy Hangman
Apple II and IIe, grades 7-12. Popular word guessing game using energy words and definitions. Includes software to allow teacher to input his or her own set of terms.

Available From:
HRM Software
175 Tompkins Ave.
Pleasantville, NY 10570

Heat and Temperature
Apple IIe and Commodore 64, grades 7-12. Program, temperature probes, and pulsing heating device for using the microcomputer as a laboratory tool. Teachers guide with sample laboratory activities. Developed by Technical Education Research Collaborative (TERC).

Motion
Apple IIe and Commodore 64, grades 7-12. Program and motion detector for microcomputer based labs. Teachers guide with laboratory experiments. Developed by TERC.



Available From:
National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

Each of the following includes a disk, documentation and a teachers guide.

Electric Bill
Apple II, II+, IIe, TRS-80. Grades 5-12. Shows how electric bills are computed, how to read bills for information on energy use, and how rate structures are constructed and applied. Cost $25.00.

Energy Conversions
Apple II, II+, IIe, TRS-80. Grades 7-12. Can be used to convert one energy unit to another so that trends and fluctuations can be compared. Cost $29.00.

Home Energy Savings
Apple II, II+, IIe, TRS-80. Grades 5-12. A game that teaches students the principles of energy conservation and cost/benefit of decision making. Cost $35.00.

Personal Energy Inventory
Apple II, II+, IIe, TRS-80. Grades 7-12. Teaches students about energy consumption by monitoring their energy use. Cost $39.00.

Power Grid
Apple II, II+, IIe, TRS-80. Grades 7-12. Simulates the operation of an electric utility, with student acting to bring individual plants on line to meet anticipated demand. Cost $59.00.

Note: The educational value of the NSTA Program increases when used with the teacher developed units produced by the Merrimack Education Center. Contact Jean Sanders, Merrimack Education Center, 101 Mill Rd., Chelmsford, MA 01824. (617) 256-3985.

The following are other usually reliable sources of software; send for catalogs.

Berkshire Biological Supply
P.O. Box 404
Florence, MA 01060
(800) 343-4054

Educational Images, LTD
P.O. Box 3456, West Side Station
Elmira, NY 14905

Hammet's Microcomputer Division
P.O. Box 545
Braintree, MA 02184

McGraw-Hill
1221 Avenue of the Americas
New York, NY 10036

Society for Visual Education Inc.
Dept. B.H.
1345 Diversey Parkway
Chicago, IL 60614

Cambridge Development Laboratory
1696 Massachusetts Avenue
Cambridge, MA 02138

The Educational Software Selector
EPIE Institute
P.O. Box 839-T
Water Mill, NY 11976

HRM Software
175 Tompkins Ave.
Pleasantville, NY 10570

Vernier Software
2920 SW 89th St.
Portland, OR 97225

INDUSTRY AND NON-PROFIT SOURCES OF MATERIALS

The following are information and educational materials available from a variety of sources. Included are public and private agencies and organizations representing various interests in the field of energy. In some cases, we've cited a specific item or items to request. In all cases, we suggest you contact the source directly to obtain a listing and/or whatever material or information they have available. These can form a useful background resource for your classroom or school library.

*Denotes utility company: materials should be requested only from utility serving your school.

Alliance to Save Energy (ASE)
1925 K Street, N.W. Suite 507
Washington, D.C. 20006
(202) 857-0666

Provides consumers with methods of saving energy and promotes energy conservation.

American Gas Association (AGA)
1515 Wilson Boulevard
Arlington, VA 22209
(703) 841-8400

Provides information on all phases of gas production, distribution, transportation, and gas-related endeavors. Many of their publications are available through the local gas utility.

American Nuclear Energy Council
410 First St., S.E.
Third Floor
Washington, D.C. 20003
(202) 484-2670

Represents organizations interested in promoting nuclear energy as a source of energy. Provides information on issues and legislation.

American Nuclear Society (ANS)
555 North Kensington Avenue
LaGrange Park, IL 60525
(312) 253-6611

Membership is made up of nuclear scientists involved in the energy field. Its publications answer questions about nuclear energy.

American Petroleum Institute (API)
1220 L Street, N.W.
Washington, D.C. 20005
(202) 457-7000

Represents petroleum producers, refiners, marketers, transporters. Provides a wide range of publications on any topic concerning petroleum.

Amoco Teaching Aids — Energy
P.O. Box 1400K
Dayton, Ohio 45414

Provides information packet and listing of free and/or inexpensive material. "Living with Energy" for grades 7-9. Studies current energy problems using five spirit masters, activities and teachers instruction.

Antioch/New England Graduate School
Know Nukes Institute
Keene, NH 03431
Mitchell Thomashow, Coordinator

Trains teachers to introduce the nuclear power controversy into the classroom. Ask for "Know Nukes: A Nuclear Power Issues Curriculum Guide."

Atomic Industrial Forum (AIF)
7101 Wisconsin Avenue
Bethesda, MD 20814
(301) 654-9260

Made up of a wide variety of groups involved in the development and utilization of nuclear energy. Provides material on nuclear power generation.

***Boston Edison**
Public Information Department
800 Boylston Street
Boston, MA 02199
(617) 424-2448 Dena Lehman,
Educational Services Coordinator

Electric utility providing wide variety of material, information, and help for the classroom teacher.

Center for Ecological Technology
148 First St.
Pittsfield, MA 01201
(413) 445-4556 Allan Silverstein,
Associate Director

Resource library, slide shows, speakers.

Center for Renewable Resources
Suite 638
1001 Connecticut Avenue, N.W.
Washington, D.C. 20036
(202) 466-6880

Publications on renewable energy use, e.g. *The Hidden Costs of Energy*.

Channing L. Bete Co., Inc.
200 State Street
South Deerfield, MA 01373
(413) 665-7611

Energy and resources conservation booklets. Single review copy free; quantity pricing on request; send for catalog.

Chevron, U.S.A., Inc.
Public Affairs, Youth and Education
P.O. Box 7753
San Francisco, CA 94120

Ask for "Energy Adventure" and/or "Career Awareness."

***Commonwealth Electric**
Consumer Relations Dept.
2421 Cranberry Highway
Wareham, MA 02571
(800) 642-7030 John Farnham, Manager
of Consumer Relations

Electric utility provides educational materials and information.

Conservation and Renewable Energy Inquiry and Referral Service
P.O. Box 8900
Silver Spring, MD 20907
1-800-523-2929

Provides basic information and renewable energy technologies. Solar bibliography, free.

Cooperative Extension Service
215 Strockbridge Hall
U. Mass, Amherst, MA 01003
(413) 545-2716 Bob Schrader, Energy
Specialist — or your county office.

Supplies "Energy Challenge", resources and teacher guide.

Edison Electric Institute
Dept. of Public Relations
1111 19th Street, N.W.
Washington, D.C. 20036
(202) 828-7400

An association of investor-owned electric companies providing information on topics concerning electrical energy.

***Eastern Edison**

Fall River Office	Brockton Office
P.O. Box 511	P.O. Box 471
82 Hartwell St.	110 Mulberry St.
Fall River, MA 02722	Brockton, MA 02403
(617) 679-2194	(617) 580-1213

Contact the Education Services Coordinator

Electric Utility — send for catalog.

Electric Power Research Institute
P.O. Box 10412
Palo Alto, CA 94303

The institute is funded by electric utilities. Provides information on solar, coal, geothermal, fusion, environmental impacts, and nuclear and fossil fuel generation.

Environmental Action Foundation
1525 New Hampshire Avenue, NW
Washington, D.C. 20036
(202) 745-4870

Magazine and books on electricity and electric companies.

Exxon Company, U.S.A.
Headquarters Public Affairs
P.O. Box 2180
Houston, TX 77252

Resource information and list of material.

***Fitchburg Gas and Electric Light Co.**
285 John Fitch Highway
P.O. Box 2070
Fitchburg, MA 01420
(617) 343-6391 Thomas Conray, Jr., Manager Community Relations

Catalog of energy materials.

Food for Thought — Books
67 N. Pleasant Street
Amherst, MA 01002
(413) 253-5432

Sells many energy related books.

Franklin County Extension Service
Courthouse, 425 Main St.
Greenfield, MA 01301
(413) 774-2902 or 2903
Gisela Walker, Extension Agent

Solar models available to schools: thermo-siphoning air panel; hot water system; solar oven; make music; make things grow. Curriculum materials — send for list.

Government Printing Office
Superintendent of Documents
Washington, D.C. 20402

Catalog of energy and other materials printed by Federal Government.

Hampshire Educational Collaborative
36 Hadley St.
The Center School
South Hadley, MA 01075
(413) 534-4563 Cecelia Scaife, Director

Energy resources and materials.

Hitchcock Center for the Environment
The Carriage House, Lerch Hill
525 South Pleasant St.
Amherst, MA 01002
(413) 256-6006 Peg McDaniels, Environmental Education Resource Center Coordinator

Good resource library.

League of Women Voters
1730 M. Street, N.W.
Washington, D.C. 20036

Listing of energy and citizenship publications.

Massachusetts Audubon Society
Library
South Great Road
Lincoln, MA 01773
(617) 259-9500 ext. 7255 Tom Wellnitz, Energy Education Coordinator

Excellent resource including extensive materials for energy information and education, and copies of curricula mentioned in this guide.

Massachusetts Executive Office of Energy
Room 1500
100 Cambridge St.
Boston, MA 02202

Information on Massachusetts energy use and policy.

***Massachusetts Electric**
New England Power Service Co.
25 Research Dr.
Westborough, MA 01581
(617) 366-9011 Arthur Fox, P.E., Manager, Educational Services

Electric utility, providing wide variety of material, information, and help for the classroom teacher.

Merrimack Education Center
101 Mill Road
Chelmsford, MA 01824
(617) 256-3985 Jean Sanders, Ed D, Associate Director

Teacher developed units to be used with DATAPLOT or the NSTA software. Other energy related programs.

National Coal Association
1130 17th Street, N.W.
Washington, D.C. 20036
(202) 463-2625

A coal industry association offering a variety of publications on coal, including "Power From Coal", and informative booklets, teachers guide, and classroom activities.

National Geographic Society
Educational Services
Department 82
Washington, D.C. 20016
(202) 857-7378

Teaching units on energy.

National Science Teachers Association (NSTA)
1742 Connecticut Ave., N.W.
Washington, D.C. 20009
(202) 328-5800

Teaching units and materials on energy.

National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036
(703) 790-4361

Energy related publications.

N.Y. Energy Education Project
SUNY At Albany
1400 Washington Ave.
Box 22100
Albany, NY 12222

Prepares curriculum guides.

***Northeast Utilities**
174 Brush Hill Ave.
W. Springfield, MA
(413) 787-9509 ext. 2294

Electric utility provides energy education material through catalog.

Sierra Club
Information Services
530 Bush St.
San Francisco, CA 94108

Environmental advocacy organization with energy related publications.

Tenneco Inc.
Public Affairs Department
P.O. Box 2511
Houston, TX 77001

Send for material list and "A Guide to Information Sources".

Thomas Alva Edison Foundation
Cambridge Office Plaza
Suite 141
18286 West Ten Mile Rd.
Southfield, Michigan 48075

Publishes information on Edison's life and early generation of electricity.

Union of Concerned Scientists
26 Church St.
Cambridge, MA 02238
(617) 547-5552

Publications on all aspects of nuclear energy.

U.S. Department of Energy
Public Information Office
150 Causeway St.
Boston, MA 02114
(617) 223-2525 Duane Day,
Public Information Officer

Information, publications.

U.S. Dept. of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

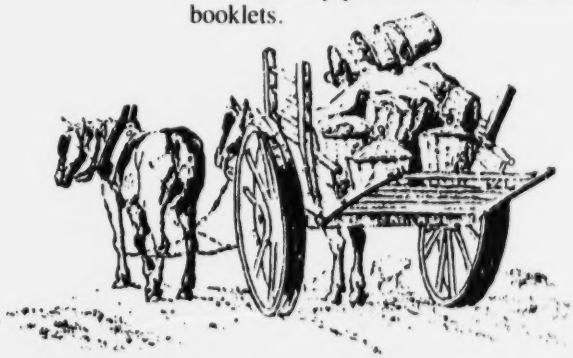
No material listing but will send packet of free material. Availability varies.

U.S. Department of Energy
Energy Information Administration
National Energy Information Center
E1-20, Forrestal Building
Washington, D.C. 20585

All areas of energy information and up-to-date energy statistics.

Worldwatch Institute
1776 Mass. Ave., N.W.
Washington, D.C. 20036
(202) 452-1999

Bi-monthly publications, informational booklets.

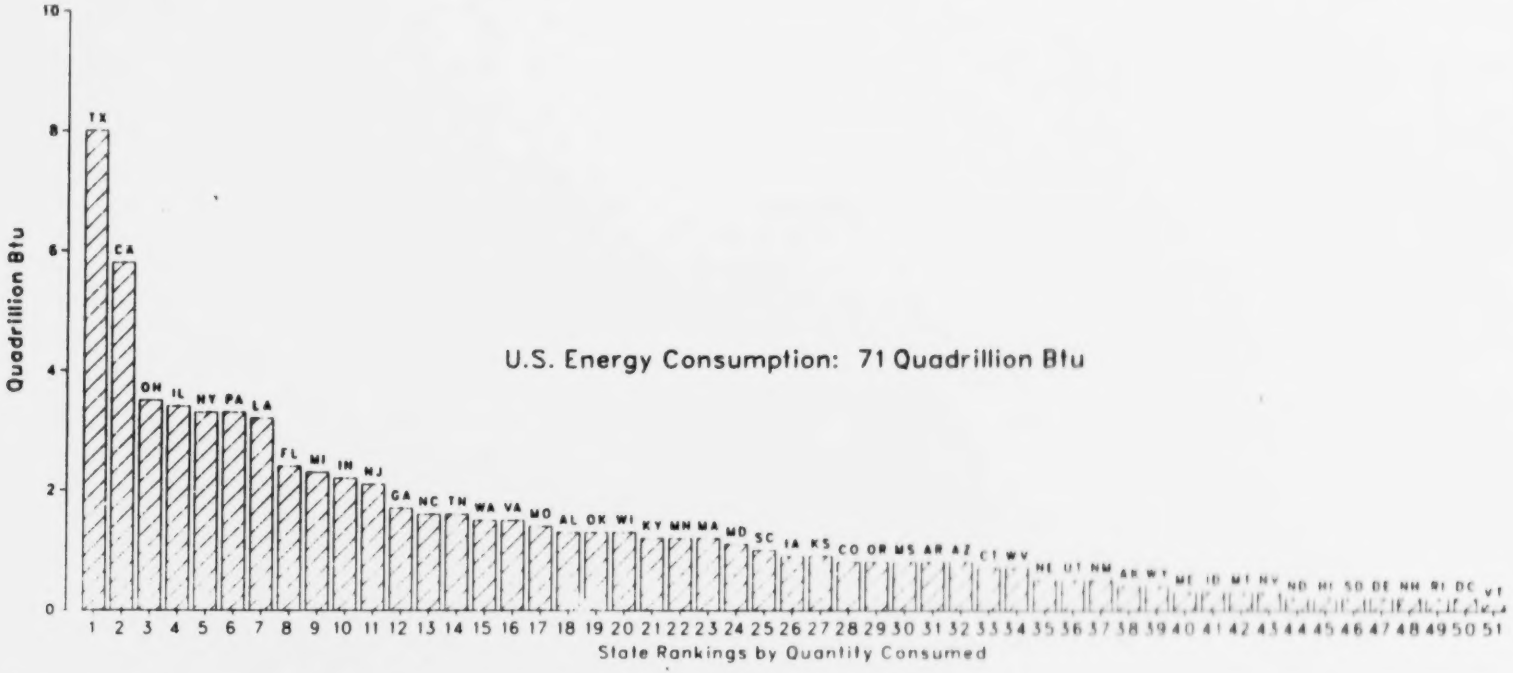


MASSACHUSETTS ENERGY STATISTICS

Listing of tables and graphs in this section

Rankings of State Energy Consumption
Rankings of State Energy Consumption per Capita
Average Annual Energy Consumption Growth Rates, Pre-and-Post Embargo (Percent)
Energy Consumption by Sector — by state
Energy Consumption by Sector — Massachusetts
Major Power Plants in Massachusetts and New England
Major Electricity Transmission Lines
Electricity Sales to Ultimate Consumers
Massachusetts Town Served by Natural Gas Pipelines
Weather Data Including Percent Possible Sunshine and Heating Degree Days
Residential Use of Wood Heat
Discussion Questions Using Energy Statistics

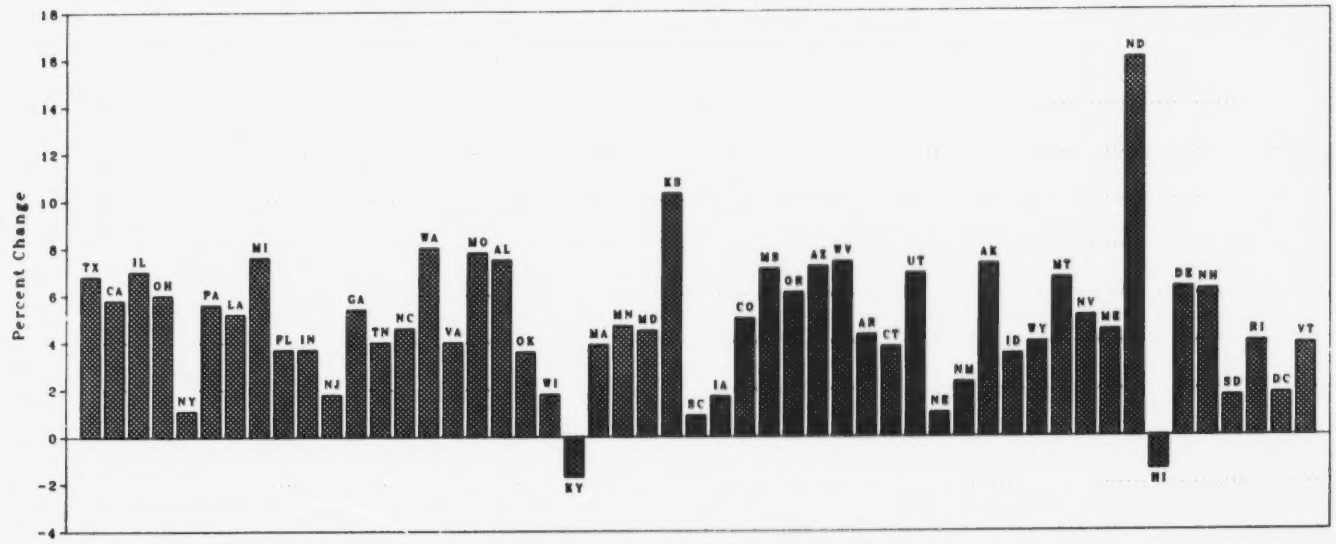
Figure ES3. Rankings of State Energy Consumption, 1983



Source: State Energy Data System, 1960–1983

State Energy Data Report 1960–1983
Energy Information Administration

Figure ES2. Percent Change in Energy Consumption Estimates by State, 1983 and 1984



Note: States are in descending order of quantity of energy consumed in 1984.
Source: State Energy Data System, 1960–1984.

Table ES2. Energy Consumption in Top 15* States, 1983 and 1960 (Trillion Btu)

1983			1960		
Rankings		Use	Rankings		Use
1	Texas	8,026	1	Texas	4,179
2	California	5,761	2	California	3,293
3	Ohio	3,522	3	Pennsylvania	3,184
4	Illinois	3,352	4	New York	3,024
5	New York	3,316	5	Ohio	2,959
6	Pennsylvania	3,256	6	Illinois	2,505
7	Louisiana	3,207	7	Michigan	1,840
8	Florida	2,418	8	Indiana	1,503
9	Michigan	2,341	9	Louisiana	1,404
10	Indiana	2,186	10	New Jersey	1,297
11	New Jersey	2,084	11	Massachusetts	1,047
12	Georgia	1,666	12	Tennessee	919
13	North Carolina	1,606	13	Missouri	881
14	Tennessee	1,586	14	Wisconsin	848
15	Washington	1,537	15	Alabama	830

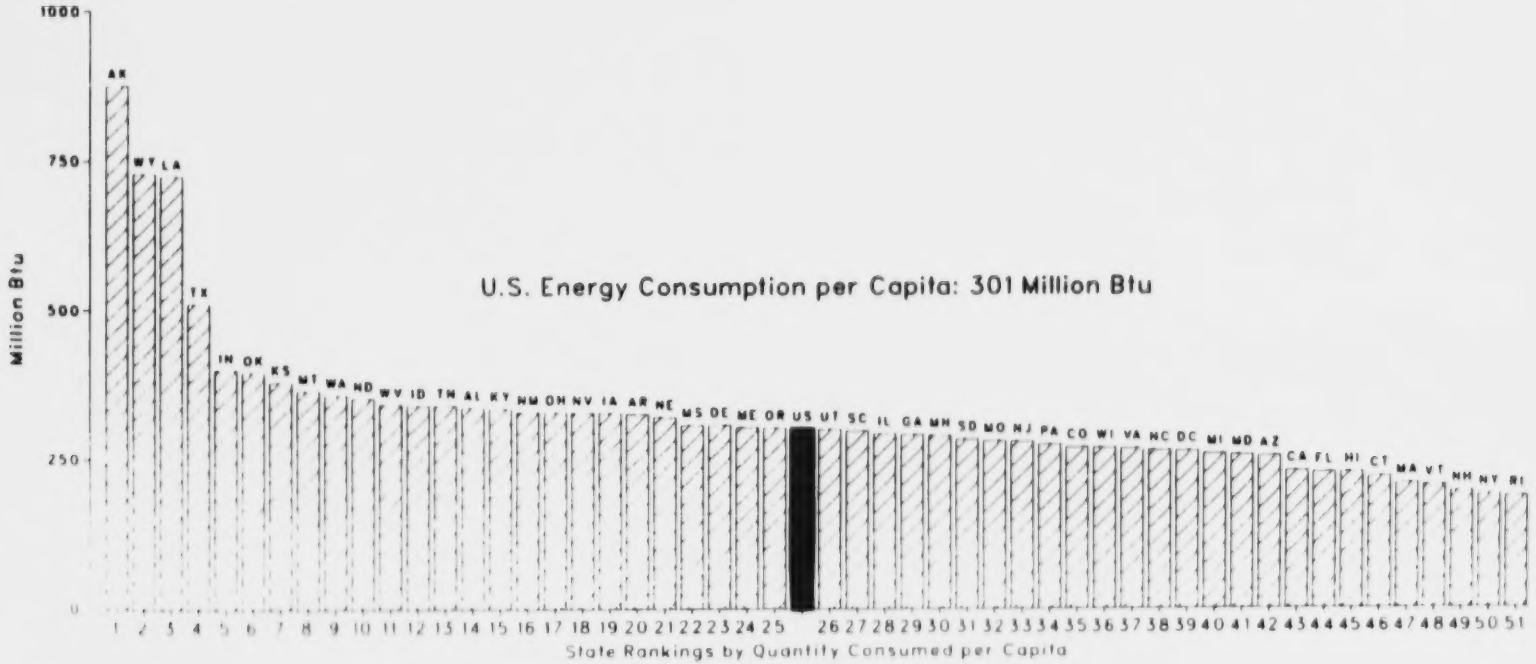
*States that consumed the most energy.
Source: State Energy Data System, 1960-1983.

Table ES3. Per Capita Energy Consumption in Top 15* States, 1983 and 1960 (Million Btu)

1983			1960		
Rankings		Use	Rankings		Use
1	Alaska	875	1	Texas	434
2	Wyoming	728	2	Louisiana	431
3	Louisiana	723	3	Wyoming	409
4	Texas	510	4	New Mexico	342
5	Indiana	399	5	Utah	330
6	Oklahoma	395	6	Montana	322
7	Kansas	379	7	Indiana	321
8	Montana	364	8	West Virginia	315
9	Washington	357	9	Nevada	304
10	North Dakota	351	10	Ohio	304
11	West Virginia	341	11	Delaware	303
12	Idaho	339	12	Pennsylvania	281
13	Tennessee	339	13	Kansas	281
14	Alabama	336	14	Idaho	279
15	Kentucky	334	15	Alaska	268

*States that consumed the most energy per capita.
Source: State Energy Data System, 1960-1983.

Figure ES4. Rankings of State Energy Consumption per Capita, 1983


1000
750
500
250
0
Million Btu
U.S. Energy Consumption per Capita: 301 Million Btu
AK WY LA TX IN OK KS MT WA ND WV ID TN AL KY NM OH NV IA AR NE MS DE ME OR US UT SC IL GA MN SD MO NJ PA CO WI VA NC DC MI MD AZ CA FL HI CT MA VT NH NY RI
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
State Rankings by Quantity Consumed per Capita

Source: State Energy Data System, 1960-1983

State Energy Data Report 1960-1983
Energy Information Administration

Table ES1. Energy Consumption Estimates by State, 1984

Rank	State	Total Consumption (Trillion Btu)	State	Consumption per Capita (Million Btu)
1	Texas	8,685	Alaska	947
2	California	6,322	Louisiana	748
3	Illinois	3,660	Wyoming	664
4	Ohio	3,630	Texas	543
5	New York	3,485	Kansas	417
6	Pennsylvania	3,428	Indiana	409
7	Louisiana	3,336	Oklahoma	407
8	Michigan	2,524	Montana	404
9	Florida	2,478	West Virginia	404
10	Indiana	2,251	North Dakota	386
11	New Jersey	1,954	Washington	377
12	Georgia	1,765	Tennessee	355
13	Tennessee	1,673	Alabama	350
14	North Carolina	1,670	Delaware	342
15	Washington	1,642	Nevada	340
16	Virginia	1,557	Idaho	340
17	Missouri	1,478	Ohio	338
18	Alabama	1,398	New Mexico	334
19	Oklahoma	1,342	Kentucky	331
20	Wisconsin	1,278	Arkansas	331
21	Kentucky	1,234	Illinois	318
22	Massachusetts	1,231	Iowa	318
23	Minnesota	1,217	Mississippi	318
24	Maryland	1,142	Nebraska	317
25	Kansas	1,016	Utah	313
26	South Carolina	993	Oregon	308
27	Iowa	925	Georgia	302
28	Colorado	912	South Carolina	301
29	Mississippi	825	Missouri	295
30	Oregon	823	Minnesota	292
31	Arizona	797	Pennsylvania	288
32	West Virginia	789	Colorado	287
33	Arkansas	778	Michigan	278
34	Connecticut	678	Virginia	276
35	Utah	518	North Carolina	271
36	Nebraska	509	Wisconsin	268
37	New Mexico	475	District of Columbia	268
38	Alaska	473	South Dakota	264
39	Idaho	340	Maryland	263
40	Wyoming	339	Arizona	261
41	Montana	333	New Jersey	260
42	Nevada	310	Maine	255
43	Maine	295	California	247
44	North Dakota	265	Florida	226
45	Hawaii	234	Hawaii	225
46	Delaware	210	Connecticut	215
47	New Hampshire	192	Massachusetts	212
48	South Dakota	186	Vermont	212
49	Rhode Island	183	New Hampshire	197
50	District of Columbia	167	New York	197
51	Vermont	112	Rhode Island	190
	United States	74,045	United States	314

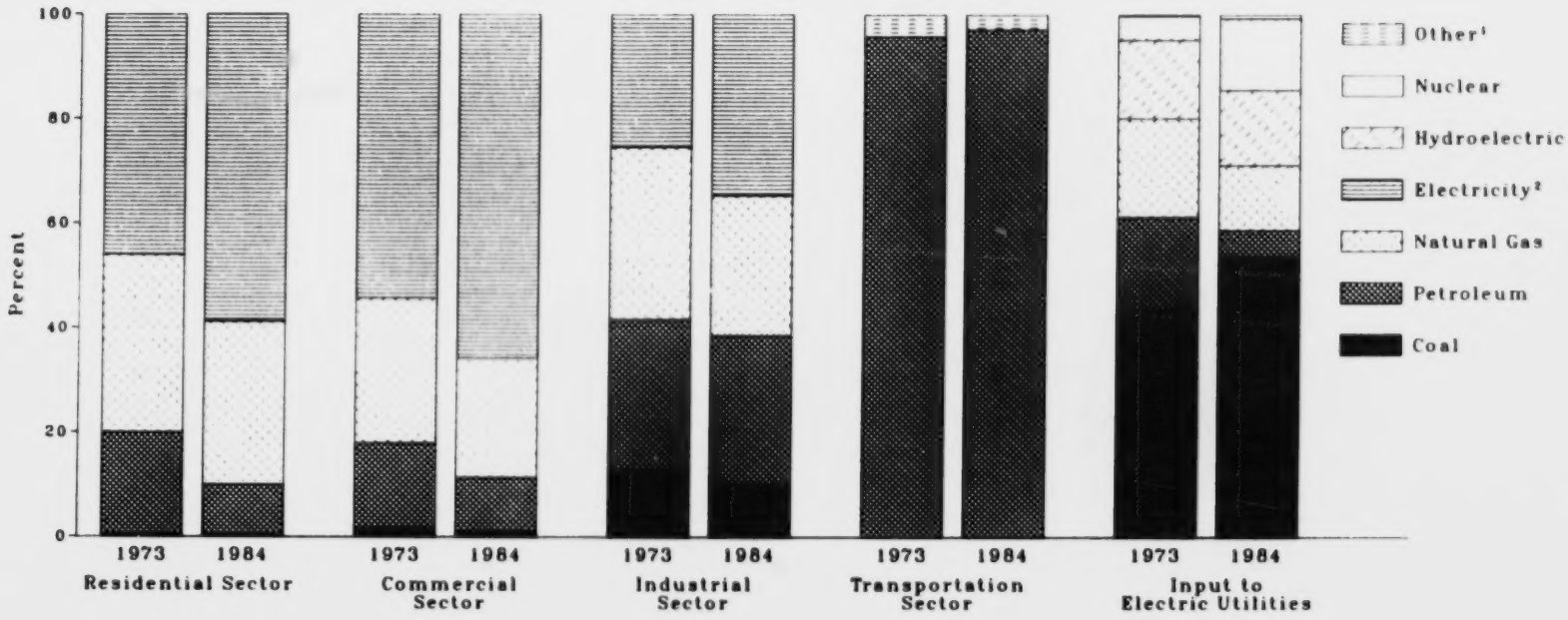
Source: State Energy Data System, 1960-1984.

Table ES3. Average Annual Estimated Energy Consumption Growth Rates, Pre- and Post-Embargo (Percent)

	Total Energy Use		Per Capita Energy Use	
	1960 Through 1973	1973 Through 1984	1960 Through 1973	1973 Through 1984
Alabama	4.6	-0.5	3.9	-1.4
Alaska	9.4	8.4	6.3	4.4
Arizona	7.0	1.8	3.1	-1.5
Arkansas	5.6	-0.2	4.5	-1.4
California	4.4	0.6	2.2	-1.2
Colorado	5.1	1.1	2.4	-1.1
Connecticut	3.0	-0.7	1.6	-0.9
Delaware	3.9	-1.0	1.9	-1.6
District of Columbia	2.1	-3.6	2.4	-2.2
Florida	7.3	2.3	3.6	-0.7
Georgia	6.8	1.7	5.0	0.1
Hawaii	6.8	0.3	4.5	-1.5
Idaho	4.7	0.4	3.4	-1.8
Illinois	3.7	-0.8	2.8	-1.0
Indiana	3.9	-0.9	2.8	-1.1
Iowa	3.7	-0.3	3.4	-0.5
Kansas	3.4	0.4	3.1	-0.3
Kentucky	3.3	0	2.5	-0.9
Louisiana	6.1	0.5	4.9	-1.0
Maine	4.4	-1.3	3.8	-2.2
Maryland	4.5	-0.3	2.3	-0.8
Massachusetts	3.3	-2.0	2.4	-2.0
Michigan	4.0	-1.7	2.9	-1.7
Minnesota	4.5	-0.2	3.5	-0.8
Mississippi	6.7	0	6.1	-0.9
Missouri	3.8	0.4	3.0	0
Montana	3.4	-0.1	2.8	-1.3
Nebraska	4.2	-0.2	3.6	-0.6
Nevada	7.7	2.8	2.3	-1.5
New Hampshire	5.5	-0.5	3.3	-2.3
New Jersey	4.1	-0.9	2.6	-1.1
New Mexico	2.8	0.3	1.7	-2.0
New York	3.1	-2.1	2.5	-1.8
North Carolina	5.4	1.1	4.0	-0.2
North Dakota	2.0	2.9	2.0	2.1
Ohio	2.7	-1.3	1.9	-1.3
Oklahoma	4.6	2.5	3.4	0.7
Oregon	5.1	0.3	3.3	-1.3
Pennsylvania	2.2	-2.0	1.8	-1.9
Rhode Island	1.6	-2.0	0.6	-1.8
South Carolina	5.1	1.4	3.9	-0.2
South Dakota	2.5	0.5	2.5	0.1
Tennessee	4.2	0.6	3.0	-0.6
Texas	4.7	0.8	2.9	-1.8
Utah	3.4	1.1	1.3	-2.1
Vermont	5.4	-0.6	3.9	-1.7
Virginia	4.4	1.1	2.7	-0.2
Washington	5.1	1.3	3.5	-0.7
West Virginia	3.2	-1.2	3.4	-1.9
Wisconsin	3.7	-0.3	2.7	-0.8
Wyoming	5.4	1.8	4.9	-1.5
United States	4.1	0.0	2.9	-1.0

Source: State Energy Data System, 1960-1984.

Figure ES1. Shares of U.S. Energy Consumption Estimates by End-Use Sector and Source, 1973 and 1984



¹Other for the transportation sector includes coal, natural gas, electricity, and electrical system energy losses. Other input to electric utilities includes geothermal energy and wood, waste, wind, photovoltaic, and solar thermal energy sources.
²Electricity includes losses incurred in the generation, transmission, and distribution of electricity.
Source: State Energy Data System, 1960–1984.

Table ES2. State Energy Consumption Estimates by Source and End-Use Sector, 1984

(Trillion Btu)

State	Total Energy	Sources							End-Use Sectors			
		Coal	Natural Gas[1]	Petroleum	Nuclear	Hydro-electric	Other[2]	Electricity Exchanges[3]	Residential	Commercial	Industrial	Transportation
Alabama	1398	576	239	447	261	112	0	-237	255	153	657	332
Alaska	473	5	265	195	0	7	*	0	42	55	238	140
Arizona	798	326	125	322	0	163	0	-137	157	147	205	290
Arkansas	778	164	216	299	117	28	0	-47	162	112	295	208
California	6322	37	1723	3192	153	448	164	605	1152	1023	1721	2426
Colorado	912	286	237	360	1	22	*	6	220	213	185	294
Connecticut	678	1	84	651	154	4	0	-16	195	154	133	195
Delaware	210	73	54	125	0	0	0	-32	37	27	88	57
Dist. of Col.	167	3	30	48	0	0	0	86	36	70	28	33
Florida	2478	380	313	1369	260	2	*	154	595	478	418	987
Georgia	1765	683	317	759	59	43	0	-96	353	246	547	619
Hawaii	234	0	2	230	0	1	1	0	21	19	46	147
Idaho	340	9	40	104	0	137	0	51	78	65	119	79
Illinois	3660	829	1064	1283	378	1	0	105	871	692	1262	835
Indiana	2251	1213	486	675	0	5	0	-107	424	254	1130	443
Iowa	925	250	242	338	29	10	*	56	226	146	324	230
Kansas	1016	274	375	405	0	*	*	-39	181	153	430	251
Kentucky	1234	673	195	471	0	36	0	-142	255	169	473	337
Louisiana	3336	119	1644	1318	0	0	0	255	288	233	2244	572
Maine	295	4	3	185	55	90	0	-42	61	43	102	89
Maryland	1142	272	164	490	126	21	*	69	278	157	400	307
Massachusetts	1231	116	215	781	11	3	0	104	358	268	222	384
Michigan	2524	726	740	824	152	17	0	64	660	400	859	605
Minnesota	1217	232	263	495	90	20	*	116	292	185	398	342
Mississippi	825	104	277	323	2	0	0	120	152	96	334	242
Missouri	1478	591	273	582	10	16	0	6	397	260	380	440
Montana	333	90	48	152	0	115	1	-73	62	55	130	86
Nebraska	509	123	139	192	62	14	0	-21	128	109	128	144
Nevada	310	156	44	145	0	58	0	-92	62	40	88	120
New Hampshire	192	33	11	125	0	13	0	10	57	26	48	61
New Jersey	1954	83	431	1074	61	-3	0	308	452	375	531	596
New Mexico	475	253	167	234	0	1	0	-180	64	81	188	142
New York	3485	309	815	1744	229	495	*	-106	916	863	744	963
North Carolina	1670	559	148	669	219	66	0	9	384	259	544	482
North Dakota	265	258	31	124	0	74	0	-223	52	32	108	73
Ohio	3630	1388	809	1134	47	2	2	249	796	534	1553	747
Oklahoma	1342	229	674	449	0	24	0	-35	266	195	548	334
Oregon	823	11	81	326	51	484	0	-130	188	139	254	243
Pennsylvania	3428	1441	697	1234	233	15	0	-192	807	472	1390	759
Rhode Island	183	*	33	96	0	*	0	54	56	37	37	53
South Carolina	993	247	112	346	251	33	0	4	191	133	404	265
South Dakota	186	34	25	95	0	59	0	-27	50	27	47	63
Tennessee	1673	547	213	549	135	106	0	123	353	254	631	434
Texas	8685	1080	3542	3993	0	11	1	58	1027	943	4865	1850
Utah	518	187	119	184	0	14	1	12	107	60	220	129
Vermont	112	1	5	60	36	12	2	-4	38	16	23	36
Virginia	1557	311	148	670	184	12	0	232	351	293	416	496
Washington	1642	82	130	553	57	932	1	-114	380	278	603	380
West Virginia	789	919	128	253	0	12	0	-523	126	78	430	155
Wisconsin	1278	362	314	459	116	24	1	3	332	225	407	313
Wyoming	339	361	88	121	0	13	*	244	41	33	196	70
United States	**74045**	**17012**	**18505**	**31053**	**3538**	**3774**	**174**		**15031**	**11375**	**27761**	**19878**

[1] Includes supplemental gaseous fuels.
[2] Other is geothermal energy and wood, waste, wind, photovoltaic, and solar thermal energy sources consumed at electric utilities to produce electricity.
[3] Net interstate sales of electricity, including associated electrical system energy losses.
* Number less than 0.5.

Note: Totals may not equal sum of components due to independent rounding.

Note: U.S. total energy and U.S. industrial sector include -11 trillion Btu of net imports of coal coke which has not been allocated to the States. End-use sector data include electricity sales and associated electrical system energy losses.

Sources: Data sources, estimation procedures, and assumptions are described in the documentation section of this report.

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Table ES4. Petroleum Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	Texas	3,993	3	1,551	1979	4,236
2	California	3,192	1	1,843	1979	3,737
3	New York	1,744	2	1,699	1973	2,948
4	Florida	1,369	10	607	1980	1,664
5	Louisiana	1,318	12	469	1979	1,639
6	Illinois	1,283	5	1,096	1978	1,805
7	Pennsylvania	1,234	4	1,126	1978	1,733
8	Ohio	1,134	8	800	1979	1,427
9	New Jersey	1,074	6	954	1973	1,643
10	Michigan	824	9	713	1978	1,258

*States that consumed the most petroleum in 1984.
Source: State Energy Data System, 1960–1984.

Table ES5. Natural Gas Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	Texas	3,542	1	2,815	1973	4,719
2	California	1,723	2	1,302	1972	2,245
3	Louisiana	1,644	3	1,004	1978	2,292
4	Illinois	1,064	6	536	1971	1,267
5	New York	815	7	434	1984	815
6	Ohio	809	4	725	1972	1,179
7	Michigan	740	8	383	1974	958
8	Pennsylvania	697	5	540	1972	851
9	Oklahoma	674	10	319	1979	845
10	Indiana	466	13	220	1972	593

*States that consumed the most natural gas in 1984.
Source: State Energy Data System, 1960–1984.

Table ES6. Coal Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	Pennsylvania	1,441	1	1,531	1973	1,799
2	Ohio	1,388	2	1,269	1977	1,669
3	Indiana	1,213	4	796	1984	1,213
4	Texas	1,080	29	25	1984	1,080
5	West Virginia	919	9	355	1984	919
6	Illinois	829	3	915	1966	1,072
7	Michigan	726	6	653	1968	934
8	Georgia	683	23	89	1984	683
9	Kentucky	673	12	287	1981	674
10	Missouri	591	15	171	1984	591

*States that consumed the most coal in 1984.
Source: State Energy Data System, 1960–1984.

Table ES7. Electricity Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	Texas	710	6	122	1984	710
2	California	598	2	195	1984	598
3	Ohio	409	1	197	1979	415
4	New York	385	3	159	1984	385
5	Illinois	360	7	116	1984	360
6	Pennsylvania	347	4	134	1984	347
7	Florida	346	14	57	1984	346
8	Washington	284	10	89	1984	284
9	Michigan	247	9	94	1984	247
10	Tennessee	245	5	133	1977	257

*States that consumed the most electricity in 1984.
Source: State Energy Data System, 1960–1984.

Table ES8. Residential Energy Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	California	1,152	4	574	1979	1,237
2	Texas	1,027	7	353	1984	1,027
3	New York	916	1	702	1972	1,107
4	Illinois	871	5	534	1978	1,004
5	Pennsylvania	807	2	663	1978	886
6	Ohio	796	3	591	1978	920
7	Michigan	660	6	447	1972	747
8	Florida	595	21	128	1984	595
9	New Jersey	452	9	303	1973	528
10	Indiana	424	10	255	1978	476

*States with the highest residential energy consumption in 1984.
Source: State Energy Data System, 1960–1984.

Table ES9. Commercial Energy Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	California	1,023	2	436	1981	1,133
2	Texas	943	6	198	1984	943
3	New York	863	1	565	1973	977
4	Illinois	692	3	352	1978	710
5	Ohio	534	5	281	1984	534
6	Florida	478	13	100	1984	478
7	Pennsylvania	472	4	315	1984	472
8	Michigan	400	8	191	1980	422
9	New Jersey	375	9	168	1976	389
10	Virginia	293	14	88	1984	293

*States with the highest commercial energy consumption in 1984.
Source: State Energy Data System, 1960–1984.

Table ES10. Industrial Energy Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	Texas	4,865	1	3,048	1980	5,460
2	Louisiana	2,244	6	1,043	1978	2,719
3	California	1,721	4	1,146	1979	1,900
4	Ohio	1,553	3	1,605	1979	2,133
5	Pennsylvania	1,390	2	1,704	1966	2,147
6	Illinois	1,262	5	1,098	1973	1,553
7	Indiana	1,130	7	871	1979	1,422
8	Michigan	859	9	795	1973	1,210
9	New York	744	8	860	1966	1,178
10	Alabama	657	11	485	1979	868

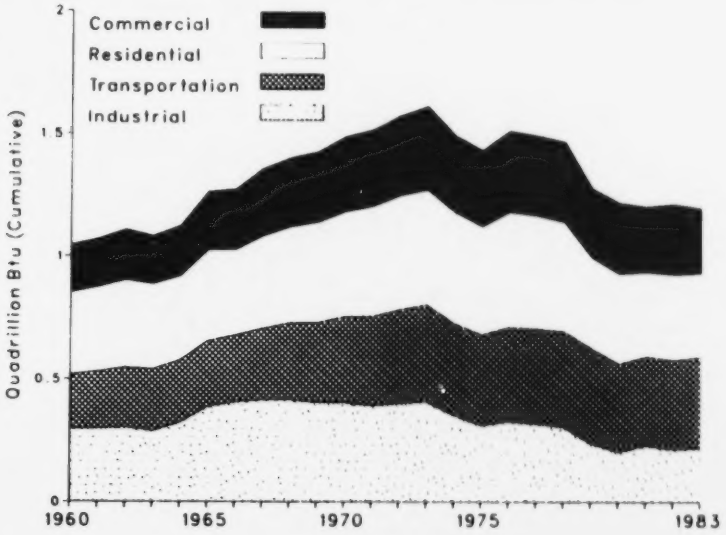
*States with the highest industrial energy consumption in 1984.
Source: State Energy Data System, 1960–1984.

Table ES11. Transportation Energy Consumption Estimates for the Top 10* States, 1960–1984
(Trillion Btu)

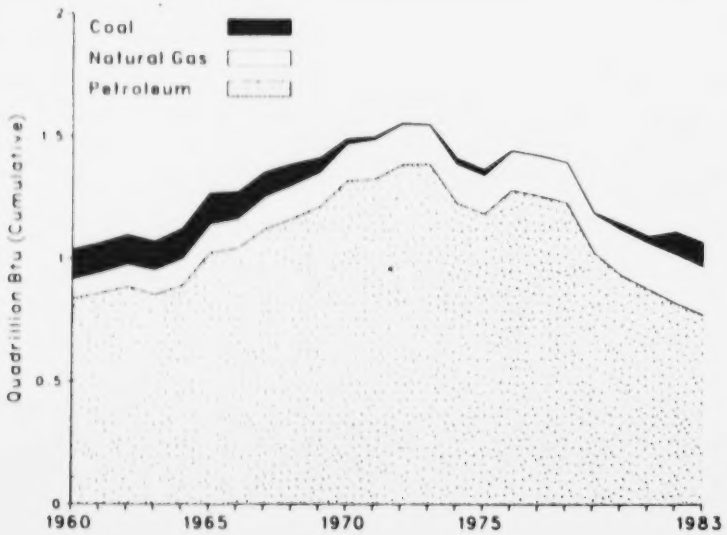
	1984		1960		Peak	
	Ranking	Use	Ranking	Use	Year	Use
1	California	2,426	1	1,222	1984	2,426
2	Texas	1,850	3	795	1979	1,879
3	Florida	987	8	343	1984	987
4	New York	963	2	804	1973	1,182
5	Illinois	835	5	505	1978	976
6	Pennsylvania	759	4	532	1978	864
7	Ohio	747	6	487	1978	837
8	Georgia	619	16	204	1984	619
9	Michigan	605	7	382	1976	696
10	New Jersey	596	9	338	1984	596

*States with the highest transportation energy consumption in 1984.
Source: State Energy Data System, 1960–1984.

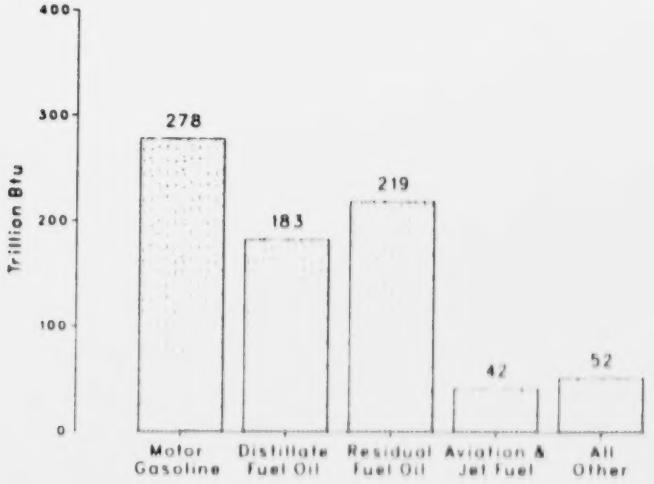
Consumption of Energy by End-Use Sector



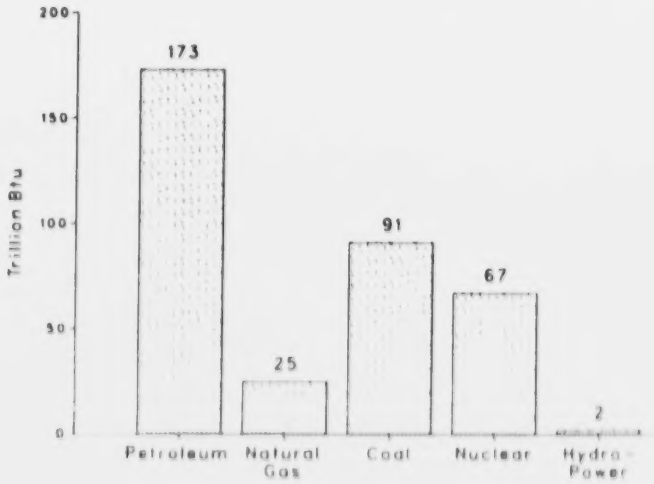
Consumption of Major Fossil Fuels



Petroleum Consumption by Product Type, 1983



Energy Input at Electric Utilities, 1983



Source: State Energy Data System, 1960-1983

Energy Consumption Estimates by Source, 1960-1984, Massachusetts

Year	Coal	Natural Gas[1]	Petroleum										Nuclear Electric Power	Hydroelectric Power[2]	Geothermal Energy	Other[3]	Net Interstate Sales of Electricity[4]
			Asphalt and Road Oil	Aviation Gasoline	Distillate Fuel	Jet Fuel	Kerosene	LPG[5]	Lubricants	Motor Gasoline	Residual Fuel	Other	Total						
	Thousand Short Tons	Billion Cubic Feet	Thousand Barrels											Million Kilowatthours					
1960	4560	78	2270	942	51240	1158	5718	1148	799	34993	39108	1255	138631	34	982	0	8	-726	
1961	4649	82	2270	821	52484	1501	5524	1095	778	36123	40202	1248	142045	854	814	0	0	-1658	
1962	4646	89	2295	1404	53674	2011	5322	1267	826	37048	41273	1240	146360	689	791	0	0	-2016	
1963	4470	98	2253	1563	51541	2350	4790	1335	826	37926	37328	790	140702	941	708	0	0	-5571	
1964	4728	107	2353	1731	50091	2357	4050	1382	867	38321	42624	1360	145137	1189	670	0	0	-6563	
1965	4933	114	2487	1578	55825	3118	3496	1511	915	39752	54207	1419	164688	966	664	0	0	-6519	
1966	4397	116	2669	1143	50436	3680	2517	1410	951	41250	61113	1185	166353	1082	803	0	0	-6037	
1967	4002	128	2811	580	54341	5366	2153	1374	788	42338	67635	1099	178484	1273	799	0	0	-2455	
1968	3484	133	2523	295	56762	6502	1918	1642	866	44897	69233	1205	185843	1218	783	0	0	2616	
1969	2443	137	2867	264	58552	7426	2008	1727	930	46553	72969	1279	194574	1143	881	0	0	7194	
1970	910	147	2643	250	59239	7819	2103	1820	947	49528	86130	1327	212906	1209	753	0	0	-1517	
1971	535	156	2825	237	61616	8595	2231	1852	899	50831	83869	1253	214209	1435	706	0	0	-1718	
1972	317	160	2550	272	64264	8960	2078	2164	963	53634	87842	1352	223999	1499	859	0	0	-247	
1973	221	156	3149	252	64628	8988	1347	2131	974	55596	86191	1494	224751	5120	560	0	0	12944	
1974	1119	155	2658	258	60575	8180	971	2061	933	54280	69100	1512	200528	2885	428	0	0	6844	
1975	1016	154	1832	206	58665	7971	847	2215	786	54631	65975	1354	194680	3781	417	0	0	6718	
1976	170	156	2049	220	62879	8032	1019	2556	873	56310	74384	1849	210172	3664	490	0	0	7457	
1977	167	160	1920	271	61008	8773	1045	2984	840	56962	71513	1987	207304	3675	422	0	0	2582	
1978	131	161	1842	362	58788	8470	804	2785	902	57539	69849	2190	203531	5570	214	0	0	5077	
1979	185	156	1448	269	43445	8734	793	2234	944	55533	57530	2457	173387	6077	438	0	0	11396	
1980	875	183	1231	274	37613	8573	698	2125	841	51443	54143	2521	159462	3232	158	0	0	16824	
1981	1046	185	1312	209	32035	7831	430	2572	806	52079	49418	3271	149965	4331	430	0	0	16208	
1982	3441	195	1173	166	31906	7493	768	2157	735	51956	42111	2437	141093	4173	252	0	0	17380	
1983	3669	192	1131	148	31557	7840	239	2169	770	52923	35004	2559	134340	6063	278	0	0	30502	
1984	4418	209	1098	138	33516	8930	158	1642	821	53880	34473	2983	137638	1035	297	0	0		

Year	Coal	Natural Gas[1]	Petroleum										Nuclear Electric Power	Hydroelectric Power[2]	Geothermal Energy	Other[3]	Net Interstate Sales of Electricity[4]	Total
			Asphalt and Road Oil	Aviation Gasoline	Distillate Fuel	Jet Fuel	Kerosene	LPG[5]	Lubricants	Motor Gasoline	Residual Fuel	Other	Total						
	Trillion Btu																		
1960	118.9	80.6	15.1	4.8	298.5	6.5	32.4	4.6	4.8	183.8	245.9	7.4	803.7	0.4	10.6	0.0	0.0	-2.5	1011.6
1961	120.6	84.6	15.1	4.1	305.7	8.4	31.3	4.4	4.7	189.8	252.7	7.3	823.6	9.9	8.7	0.0	0.0	-11.5	1035.9
1962	119.9	92.1	15.2	7.1	312.7	11.3	30.2	5.1	5.0	194.6	259.5	7.3	847.9	8.0	8.4	0.0	0.0	-5.7	1070.7
1963	116.0	101.5	15.0	7.9	300.2	13.2	27.2	5.4	5.0	199.2	234.7	4.5	812.2	11.2	7.4	0.0	0.0	-6.9	1041.4
1964	123.4	110.1	15.6	8.7	291.8	13.2	23.0	5.5	5.3	201.3	268.0	7.4	839.8	14.2	7.0	0.0	0.0	-19.0	1075.6
1965	127.9	117.9	19.0	8.0	325.2	17.6	19.8	6.1	5.6	208.8	340.8	7.7	958.5	11.4	6.9	0.0	0.0	-22.2	1200.5
1966	112.1	120.0	17.7	5.8	293.8	20.8	14.3	5.7	5.8	216.7	384.2	6.4	971.0	12.6	8.4	0.0	0.0	-22.2	1201.9
1967	101.5	132.3	18.7	2.9	316.5	30.3	12.2	5.3	4.8	222.4	425.2	5.9	1044.2	14.7	8.3	0.0	0.0	-20.6	1280.4
1968	87.7	137.0	16.7	1.5	330.6	36.7	10.9	6.3	5.3	235.8	435.3	6.5	1085.6	13.8	8.1	0.0	0.0	-8.4	1323.8
1969	60.4	141.2	19.0	1.3	341.1	42.0	11.4	6.6	5.6	244.5	458.8	6.9	1137.2	12.6	9.2	0.0	0.0	-8.9	1351.7
1970	21.4	151.9	18.9	1.3	345.1	44.2	11.9	6.9	5.7	260.2	541.5	7.1	1242.8	13.3	7.9	0.0	0.0	-24.5	1412.7
1971	13.1	161.3	18.7	1.2	358.9	48.6	12.6	7.0	5.5	267.0	527.3	6.8	1253.6	15.6	7.4	0.0	0.0	-5.2	1445.8
1972	7.7	164.6	16.9	1.4	374.5	50.1	11.8	8.1	5.8	281.7	552.3	7.3	1310.0	16.2	8.9	0.0	0.0	-5.9	1501.5
1973	5.2	158.7	20.9	1.3	376.5	50.9	7.6	8.0	5.9	292.0	541.9	8.1	1313.1	55.8	5.8	0.0	0.0	-0.8	1537.7
1974	25.6	159.0	17.6	1.3	352.9	46.3	5.5	7.7	5.7	285.1	434.4	8.2	1164.7	32.2	4.5	0.0	0.0	44.2	1430.1
1975	24.3	157.1	12.2	1.0	341.7	45.1	4.9	8.6	4.8	287.0	414.8	7.4	1127.4	41.6	4.3	0.0	0.0	23.4	1378.1
1976	4.0	159.2	13.6	1.1	366.3	45.5	5.8	9.5	5.3	295.8	467.7	10.1	1220.6	40.5	5.1	0.0	0.0	22.9	1452.2
1977	4.0	163.4	12.7	1.4	355.4	49.6	5.9	11.0	5.1	299.2	449.6	10.9	1200.9	39.6	4.4	0.0	0.0	25.4	1437.8
1978	3.2	163.1	12.2	1.8	342.4	47.9	4.6	10.2	5.5	302.3	439.1	12.1	1178.1	60.9	2.2	0.0	0.0	8.8	1416.4
1979	4.6	159.4	9.6	1.4	253.1	49.4	4.5	8.2	5.7	291.7	361.7	13.4	998.8	66.1	4.5	0.0	0.0	17.3	1250.8
1980	22.9	187.0	8.2	1.4	219.1	48.5	4.0	7.8	5.1	270.2	340.4	13.7	918.4	35.3	1.6	0.0	0.0	38.9	1204.0
1981	26.9	189.3	8.7	1.1	186.6	44.3	2.4	9.4	4.9	273.6	310.7	17.8	859.4	47.8	4.5	0.0	0.0	57.4	1185.3
1982	90.1	200.3	7.8	0.8	185.9	42.4	4.4	7.8	4.5	272.9	264.8	14.2	805.4	46.2	2.6	0.0	0.0	55.3	1200.0
1983	97.1	197.7	7.5	0.7	183.8	44.4	1.4	7.8	4.7	278.0	220.1	14.0	762.3	66.1	2.9	0.0	0.0	59.3	1185.5
1984	116.4	215.2	7.3	0.7	195.2	50.5	0.9	5.9	5.0	283.0	216.7	16.0	781.3	11.2	3.1	0.0	0.0	104.1	1231.2

[1] Includes supplemental gaseous fuels.
[2] Liquefied petroleum gases (LPG) series estimates since 1979 may be affected by the changing data sources and estimation procedures. See the LPG notes in the documentation.
[3] Includes industrial and electric utility production, and net imports of electricity.
[4] Other is wood, waste, wind, photovoltaic, and solar thermal energy sources consumed at electric utilities to produce electricity.
[5] Net interstate sales of electricity is the difference between the amounts of energy in the electricity sold within a State (including associated losses) and the energy input at the electric utilities within the State. The net interstate sales, therefore, include associated electrical system energy losses. A positive number indicates that more electricity (including associated losses) came into the State than went out of the State during the year; conversely, a negative number indicates that more electricity (including associated losses) went out of the State than came into the State.
* Btu value less than 0.05, and physical unit value than 0.5.
Note: Totals may not equal sum of components due to independent rounding.
Note: Does not include wood consumed by the non-electric utility sectors. Also excludes small quantities of other energy sources for which consistent historical data are not available, such as solar energy obtained by the use of thermal and photovoltaic collectors, and geothermal, biomass, waste, and wind energy other than that consumed at electric utilities.
Sources: Data sources, estimation procedures, and assumptions are described in the documentation section of this report.

Residential Energy Consumption Estimates, 1960-1984, Massachusetts

Year	Coal			Natural Gas[1]	Petroleum				Electricity Sales	Electrical System Energy Losses[2]		
	Bituminous Coal and Lignite	Anthracite	Total		Distillate Fuel	Kerosene	LPG[3]	Total			Subtotal	Total
	Thousand Short Tons			Billion Cubic Feet	Thousand Barrels				Million Kilowatthours			
1960	**141**	**253**	**394**	**85**	**34305**	**1858**	**752**	**39915**	**4190**	**10425**		
1961	94	230	324	50	35292	4719	666	40677	4466	10884		
1962	102	200	302	54	36192	4587	805	41584	4718	11343		
1963	53	190	243	58	34276	4087	829	39192	5030	12013		
1964	49	181	230	62	33151	3270	829	37250	5361	12746		
1965	**37**	**159**	**196**	**65**	**37082**	**2682**	**926**	**10689**	**5766**	**13743**		
1966	38	135	173	66	33128	1905	810	35842	6222	14899		
1967	46	121	167	73	35775	1635	813	38223	6929	16520		
1968	36	114	150	75	36820	1415	873	39108	7578	18047		
1969	20	101	121	78	37934	1420	977	40332	8406	20054		
1970	**9**	**97**	**106**	**83**	**38530**	**1434**	**933**	**40897**	**9335**	**22632**		
1971	5	92	98	83	40113	1427	943	42483	10200	24675		
1972	4	71	75	86	41406	1512	1048	43966	10965	26327		
1973	9	70	79	84	41628	1041	964	43632	11715	28066		
1974	10	62	72	85	39084	637	947	40668	11443	27915		
1975	**6**	**51**	**57**	**90**	**37860**	**591**	**1006**	**39456**	**10648**	**25698**		
1976	5	49	54	95	41000	644	1064	42707	11227	27028		
1977	5	46	51	93	39889	672	1176	41737	11089	26766		
1978	0	38	38	87	38110	456	1130	39696	11242	27503		
1979	1	30	31	81	26272	433	645	27350	11422	27564		
1980	**14**	**37**	**51**	**94**	**22712**	**323**	**675**	**23710**	**11571**	**28135**		
1981	16	55	71	97	18702	181	713	19596	11684	27853		
1982	29	47	76	98	18086	510	713	19309	11986	28771		
1983	24	44	68	92	17563	164	848	18575	12436	29747		
1984	50	52	102	97	18011	108	906	19026	12954	30225		
	Trillion Btu											
1960	**3.5**	**6.3**	**9.8**	**46.6**	**199.8**	**27.5**	**3.0**	**230.4**	**14.3**	**301.1**	**35.6**	**336.6**
1961	2.4	5.7	8.1	51.4	205.6	26.8	2.7	235.0	15.2	309.7	37.1	346.8
1962	2.6	4.9	7.5	56.0	210.8	26.0	3.2	240.1	16.1	319.6	38.7	358.3
1963	1.3	4.6	5.9	60.0	199.7	23.2	3.3	226.2	17.2	309.3	41.0	350.2
1964	1.2	4.4	5.6	63.6	193.1	18.5	3.3	215.0	18.3	302.5	43.5	346.0
1965	**0.9**	**3.9**	**4.8**	**66.9**	**216.0**	**15.2**	**3.7**	**234.9**	**19.7**	**326.3**	**46.9**	**373.2**
1966	0.9	3.3	4.2	68.5	193.0	10.8	3.2	207.0	21.2	301.0	50.8	351.8
1967	0.9	2.8	3.7	75.8	208.4	9.3	3.1	220.8	23.6	324.0	56.4	380.3
1968	0.9	2.7	3.5	77.2	214.5	8.0	3.3	225.8	25.9	332.5	61.6	394.0
1969	0.5	2.3	2.8	80.9	221.0	8.1	3.7	232.7	28.7	345.1	68.4	413.6
1970	**0.2**	**2.3**	**2.5**	**85.2**	**224.4**	**8.1**	**3.5**	**236.1**	**31.8**	**355.6**	**77.2**	**432.9**
1971	0.1	2.2	2.3	86.0	233.7	8.1	3.6	245.3	34.8	368.4	84.2	452.6
1972	0.1	1.7	1.8	88.5	241.2	8.6	3.9	253.7	37.4	381.4	89.8	471.2
1973	0.2	1.6	1.8	85.7	242.5	5.9	3.6	252.0	40.0	379.4	95.8	475.2
1974	0.2	1.4	1.6	87.5	227.7	3.6	3.5	234.8	39.0	363.0	95.2	458.3
1975	**0.1**	**1.1**	**1.3**	**92.0**	**220.5**	**3.3**	**3.7**	**227.6**	**36.3**	**357.3**	**87.7**	**444.9**
1976	0.1	1.1	1.2	96.9	238.8	3.7	3.9	246.4	38.3	382.9	92.2	475.1
1977	0.1	1.1	1.2	95.0	232.4	3.8	4.3	240.5	37.8	374.5	91.3	465.9
1978	0.0	0.9	0.9	88.1	222.0	2.6	4.1	228.7	38.4	356.2	93.8	450.0
1979	*	0.7	0.8	82.3	153.0	2.5	2.4	157.9	39.0	279.9	94.0	373.9
1980	**0.4**	**0.8**	**1.2**	**96.7**	**132.3**	**1.8**	**2.5**	**136.6**	**39.5**	**274.0**	**96.0**	**370.0**
1981	0.4	1.3	1.7	99.1	108.9	1.0	2.6	112.6	39.9	253.2	95.0	348.3
1982	0.7	1.2	1.9	100.2	105.1	2.9	2.6	110.8	40.9	253.8	98.2	351.9
1983	0.6	1.1	1.7	94.6	102.3	0.9	3.1	106.3	42.4	245.0	101.5	346.5
1984	1.2	1.3	2.5	99.7	104.9	0.6	3.3	108.8	44.2	255.3	103.1	358.4

[1] Includes supplemental gaseous fuels.
[2] Liquefied petroleum gases (LPG) series estimates since 1979 may be affected by the changing data sources and estimation procedures. See the LPG notes in the documentation.
[3] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.
* Btu value less than 0.05, and physical unit value less than 0.5.

Note: Totals may not equal sum of components due to independent rounding.

Note: Excludes small quantities of other energy sources for which consistent historical data are not available such as: (1) wood consumed as fuel in the residential sector; (2) solar energy obtained by the use of thermal and photovoltaic collectors; (3) wind energy; and (4) geothermal, biomass, and waste energy.

Sources: Data sources, estimation procedures, and assumptions are described in the documentation section of this report.

Commercial Energy Consumption Estimates, 1960-1984, Massachusetts

Year	Coal: Bituminous Coal and Lignite	Coal: Anthracite	Coal: Total	Natural Gas[1]	Petroleum: Distillate Fuel	Petroleum: Kerosene	Petroleum: LPG[2]	Petroleum: Motor Gasoline	Petroleum: Residual Fuel	Petroleum: Total	Electricity Sales	Electrical System Energy Losses[3]
	Thousand Short Tons			Billion Cubic Feet	Thousand Barrels						Million Kilowatthours	
1960	**263**	**169**	**431**	**10**	**11965**	**404**	**133**	**135**	**10036**	**22672**	**3115**	**7750**
1961	175	153	328	12	12389	392	118	140	10005	22964	3363	8197
1962	189	133	323	14	12623	381	142	147	10483	23776	3569	8581
1963	99	126	225	15	11955	340	146	92	9352	21885	3792	9056
1964	91	121	212	15	11562	272	146	91	11077	23149	4069	9674
1965	**68**	**106**	**174**	**16**	**12933**	**223**	**163**	**92**	**14503**	**27914**	**4407**	**10501**
1966	71	90	161	19	11554	158	143	96	15841	27793	4794	11481
1967	67	81	147	25	12477	136	143	96	16149	29001	6053	14432
1968	66	76	142	25	12842	118	154	99	15801	29015	6634	15798
1969	37	67	104	30	13230	118	172	100	14669	28290	7179	17128
1970	**16**	**65**	**81**	**35**	**13438**	**119**	**165**	**102**	**14872**	**28696**	**7887**	**19122**
1971	10	62	71	37	13990	119	166	104	13887	28266	8667	20967
1972	8	47	55	37	14441	126	185	104	13844	28699	9477	22754
1973	16	47	63	39	14519	87	170	105	13988	28868	10485	25118
1974	19	41	61	37	13632	53	167	106	11127	25084	10251	25007
1975	**11**	**34**	**45**	**38**	**13204**	**49**	**178**	**109**	**9122**	**22662**	**11501**	**27757**
1976	10	32	42	38	14300	54	188	112	9774	24427	12205	29381
1977	9	31	40	41	13912	56	208	112	8633	22921	12458	30069
1978	0	26	26	46	13292	38	199	189	7524	21242	12795	31302
1979	2	20	23	47	9163	36	114	190	3777	13280	13076	31555
1980	**27**	**24**	**51**	**53**	**7510**	**30**	**119**	**191**	**4854**	**12704**	**13019**	**31655**
1981	30	36	66	50	5759	9	126	206	3149	9249	13368	31867
1982	54	32	85	61	5509	28	126	213	4227	10103	13677	32829
1983	44	29	74	40	5444	36	150	194	2440	8263	14378	34392
1984	93	35	127	41	5583	24	160	168	2366	8301	15200	35466

Year	Coal: Bituminous Coal and Lignite	Coal: Anthracite	Coal: Total	Natural Gas[1]	Petroleum: Distillate Fuel	Petroleum: Kerosene	Petroleum: LPG[2]	Petroleum: Motor Gasoline	Petroleum: Residual Fuel	Petroleum: Total	Electricity Sales	Subtotal	Electrical System Energy Losses[3]	Total
	Trillion Btu													
1960	**6.6**	**4.2**	**10.8**	**10.6**	**69.7**	**2.3**	**0.5**	**0.7**	**63.1**	**136.3**	**10.6**	**158.3**	**36.4**	**194.7**
1961	4.4	3.8	8.2	12.2	71.7	2.2	0.5	0.7	62.9	138.0	11.5	169.9	28.0	197.9
1962	4.7	3.3	8.0	14.8	73.5	2.2	0.6	0.8	65.9	142.9	12.2	178.0	29.3	207.2
1963	2.5	3.0	5.5	15.1	69.6	1.9	0.6	0.5	58.8	131.4	12.9	165.0	30.9	195.9
1964	2.3	2.9	5.2	15.3	67.4	1.5	0.6	0.5	69.6	139.6	13.9	174.0	33.0	207.0
1965	**1.7**	**2.6**	**4.3**	**16.8**	**75.3**	**1.3**	**0.7**	**0.5**	**91.2**	**168.9**	**15.0**	**205.1**	**35.8**	**240.9**
1966	1.8	2.2	3.9	19.1	67.3	0.9	0.6	0.5	99.6	168.9	16.4	208.3	39.2	247.5
1967	1.7	1.9	3.5	25.5	72.7	0.8	0.6	0.5	101.5	176.0	20.7	225.8	49.2	275.0
1968	1.6	1.8	3.4	26.2	74.8	0.7	0.6	0.5	99.3	175.9	22.6	228.1	53.9	282.1
1969	0.9	1.6	2.5	30.7	77.1	0.7	0.7	0.5	92.2	171.1	24.5	228.8	58.4	287.3
1970	**0.4**	**1.5**	**1.9**	**36.5**	**78.3**	**0.7**	**0.6**	**0.5**	**93.5**	**173.6**	**26.9**	**238.9**	**65.2**	**304.1**
1971	0.2	1.5	1.7	38.1	81.5	0.7	0.6	0.5	87.3	170.6	29.6	240.0	71.5	311.6
1972	0.2	1.1	1.3	37.8	84.1	0.7	0.7	0.5	87.0	173.1	32.3	244.5	77.6	322.2
1973	0.4	1.1	1.4	40.1	84.6	0.5	0.6	0.5	87.9	174.2	35.8	251.5	85.7	337.2
1974	0.5	0.9	1.4	38.3	79.4	0.3	0.6	0.6	70.0	150.8	35.0	225.5	85.3	310.8
1975	**0.3**	**0.8**	**1.0**	**38.6**	**76.9**	**0.3**	**0.7**	**0.6**	**57.1**	**135.8**	**39.2**	**214.6**	**94.7**	**309.3**
1976	0.2	0.7	1.0	38.5	83.3	0.3	0.7	0.6	61.4	146.3	41.6	227.4	100.2	327.7
1977	0.2	0.7	1.0	41.4	81.0	0.3	0.8	0.6	54.3	137.0	42.5	221.8	102.6	324.4
1978	0.0	0.6	0.6	46.4	77.4	0.2	0.7	1.0	47.3	126.7	43.7	217.3	106.8	324.1
1979	0.1	0.5	0.5	47.5	53.4	0.2	0.4	1.0	23.7	78.7	44.6	171.4	107.7	279.1
1980	**0.7**	**0.6**	**1.2**	**54.7**	**43.7**	**0.2**	**0.4**	**1.0**	**30.5**	**75.9**	**44.4**	**176.3**	**108.0**	**284.3**
1981	0.7	0.9	1.6	51.4	33.5	0.1	0.5	1.1	19.8	54.9	45.6	153.5	108.7	262.3
1982	1.3	0.8	2.1	62.9	32.1	0.2	0.5	1.1	26.6	60.4	46.7	172.1	112.0	284.1
1983	1.1	0.7	1.8	40.9	31.7	0.2	0.5	1.0	15.3	48.8	49.1	140.6	117.3	257.9
1984	2.3	0.9	3.2	42.5	32.5	0.1	0.6	0.9	14.9	49.0	51.9	146.5	121.0	267.5

[1] Includes supplemental gaseous fuels.
[2] Liquefied petroleum gases (LPG) series estimates since 1979 may be affected by the changing data sources and estimation procedures. See the LPG notes in the documentation.
[3] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.
[4] Btu value less than 0.05, and physical unit value less than 0.5.
Note: Totals may not equal sum of components due to independent rounding.
Note: Excludes small quantities of other energy sources for which consistent historical data are not available such as: (1) solar energy obtained by the use of thermal and photovoltaic collectors, (2) wind energy, and (3) geothermal, biomass, and waste energy.
Sources: Data sources, estimation procedures, and assumptions are described in the documentation section of this report.

Industrial Energy Consumption Estimates, 1960-1984, Massachusetts

Year	Coal: Bituminous Coal and Lignite	Coal: Anthracite	Coal: Total	Natural Gas[1]	Petroleum: Asphalt and Road Oil	Petroleum: Distillate Fuel	Petroleum: Kerosene	Petroleum: LPG[2]	Petroleum: Lubricants	Petroleum: Motor Gasoline	Petroleum: Residual Fuel	Petroleum: Other	Petroleum: Total	Industrial Hydro-Power	Electricity Sales	Electrical System Energy Losses[3]
	Thousand Short Tons			Billion Cubic Feet	Thousand Barrels									Million Kilowatthours		
1960	**1258**	**8**	**1266**	**12**	**2270**	**2322**	**456**	**280**	**356**	**133**	**17875**	**1255**	**24927**	**117**	**5075**	**12627**
1961	1150	7	1157	11	2270	2290	413	307	347	91	17895	1248	24861	126	5314	12950
1962	1030	7	1037	12	2295	2428	354	316	403	36	18592	1240	25662	118	5582	13420
1963	794	7	802	14	2253	2336	363	354	403	65	16403	790	22967	112	5723	13668
1964	601	8	609	17	2353	2361	508	400	423	67	19377	1360	26850	104	6026	14327
1965	**488**	**7**	**496**	**20**	**2867**	**2841**	**590**	**496**	**507**	**206**	**25076**	**1119**	**33912**	**100**	**6546**	**15603**
1966	316	6	322	21	2669	2648	454	449	527	167	27459	1185	35558	100	7057	16898
1967	515	6	522	19	2811	2905	382	410	396	136	28299	1099	36438	105	6578	15683
1968	358	5	363	22	2523	2992	385	605	435	68	27565	1205	35799	97	7039	16765
1969	320	4	324	22	2867	3057	469	567	497	174	25393	1279	34305	92	7339	17509
1970	**145**	**4**	**149**	**23**	**2843**	**2897**	**549**	**704**	**506**	**111**	**25742**	**1327**	**34679**	**72**	**7418**	**17984**
1971	98	3	101	26	2825	2938	685	721	447	96	24005	1253	32971	70	7515	18179
1972	116	2	118	29	2550	3072	440	904	479	103	24358	1352	33258	70	7939	19060
1973	66	2	67	26	3149	3073	220	966	498	148	24479	1494	34027	72	8417	20164
1974	77	2	79	24	2658	2746	282	913	477	116	19355	1512	28060	68	7830	19100
1975	**108**	**2**	**110**	**24**	**1832**	**2654**	**227**	**1102**	**353**	**81**	**15891**	**1354**	**23495**	**67**	**7330**	**17689**
1976	71	3	74	20	2049	2797	322	1275	392	70	17027	1849	25781	66	7785	18742
1977	74	2	76	23	1920	2820	318	1570	377	119	15026	1987	24136	48	7951	19192
1978	65	2	67	26	1842	2569	310	1426	405	89	13083	2190	21915	51	8235	20147
1979	81	1	82	21	1448	2436	324	1451	424	109	6854	2457	15503	65	8443	20375
1980	**94**	**2**	**96**	**29**	**1231**	**1886**	**345**	**1304**	**377**	**91**	**2083**	**2521**	**10418**	**63**	**8486**	**20634**
1981	60	4	65	30	1312	2322	240	1695	362	75	4719	3271	13996	63	8956	21349
1982	94	3	97	19	1173	2101	230	1275	330	97	5524	2627	13357	63	8655	20775
1983	113	1	115	35	1131	1332	39	1115	346	42	5350	2559	11914	63	9046	21637
1984	107	2	109	37	1098	1366	26	483	368	109	5189	2983	11621	63	9782	22824

Trillion Btu

Year	Coal: Bituminous Coal and Lignite	Coal: Anthracite	Coal: Total	Natural Gas[1]	Petroleum: Asphalt and Road Oil	Petroleum: Distillate Fuel	Petroleum: Kerosene	Petroleum: LPG[2]	Petroleum: Lubricants	Petroleum: Motor Gasoline	Petroleum: Residual Fuel	Petroleum: Other	Petroleum: Total	Industrial Hydro-Power	Electricity Sales	Subtotal	Electrical System Energy Losses[3]	Total
1960	**33.0**	**0.2**	**33.2**	**12.0**	**15.1**	**13.5**	**2.6**	**1.9**	**2.2**	**0.7**	**112.4**	**7.4**	**154.8**	**1.3**	**17.3**	**218.6**	**43.1**	**261.7**
1961	30.0	0.2	30.2	11.9	15.1	13.3	2.3	1.2	2.1	0.5	112.5	7.3	154.4	1.3	18.1	216.0	44.2	260.1
1962	26.9	0.2	27.1	12.3	15.2	14.1	2.0	1.3	2.4	0.2	116.9	7.3	159.5	1.2	19.0	219.1	45.8	264.9
1963	20.7	0.2	20.9	14.6	15.0	13.6	2.1	1.4	2.4	0.3	103.1	4.5	142.5	1.2	19.5	198.7	46.6	245.3
1964	15.6	0.2	15.8	17.4	15.6	13.8	2.9	1.6	2.6	0.4	121.8	7.4	166.0	1.1	20.6	220.9	48.9	269.8
1965	**12.7**	**0.2**	**12.8**	**20.4**	**19.0**	**16.5**	**3.3**	**1.6**	**3.1**	**1.1**	**157.8**	**7.7**	**210.1**	**1.0**	**22.3**	**266.7**	**53.2**	**319.9**
1966	8.1	0.1	8.3	21.7	17.7	15.4	2.6	1.8	3.2	0.9	172.6	6.4	220.6	1.0	24.1	275.7	57.7	333.4
1967	13.2	0.1	13.3	19.4	18.7	16.9	2.2	1.6	2.4	0.7	177.9	5.9	226.3	1.1	22.4	282.5	53.5	336.0
1968	9.1	0.1	9.3	23.1	16.7	17.4	2.2	2.3	2.6	0.5	173.3	6.5	221.6	1.0	24.0	278.9	57.2	336.1
1969	8.1	0.1	8.2	22.2	19.0	17.8	2.7	2.2	3.0	0.9	159.6	6.9	212.1	1.0	25.0	268.5	59.7	328.2
1970	**3.5**	**0.1**	**3.6**	**23.3**	**18.9**	**16.9**	**3.1**	**2.7**	**3.1**	**0.6**	**161.8**	**7.1**	**214.1**	**0.8**	**25.3**	**267.1**	**61.4**	**328.5**
1971	2.4	0.1	2.4	26.5	18.7	17.1	3.9	2.7	2.7	0.5	150.9	6.8	203.4	0.7	25.6	258.6	62.0	320.7
1972	2.8	*	2.8	29.6	16.9	17.9	2.5	3.4	2.9	0.5	153.1	7.3	204.6	0.7	27.1	264.8	65.0	329.9
1973	1.6	*	1.6	26.2	20.9	17.9	1.2	3.6	3.0	0.8	153.9	8.1	209.5	0.7	28.7	266.8	68.8	335.6
1974	1.8	*	1.9	25.0	17.6	16.0	1.6	3.4	2.9	0.6	121.7	8.2	172.0	0.7	26.7	226.3	65.2	291.5
1975	**2.6**	**0.1**	**2.6**	**24.5**	**12.2**	**15.5**	**1.3**	**4.1**	**2.1**	**0.4**	**99.9**	**7.4**	**142.8**	**0.7**	**25.0**	**195.6**	**60.4**	**256.0**
1976	1.7	0.1	1.8	20.6	13.6	16.3	1.8	4.7	2.4	0.4	107.1	10.1	156.4	0.7	26.6	206.0	63.9	270.0
1977	1.8	0.1	1.8	23.4	12.7	16.4	1.8	5.8	2.3	0.6	94.5	10.9	145.1	0.5	27.1	197.9	65.5	263.4
1978	1.6	*	1.6	26.4	12.2	15.0	1.8	5.2	2.5	0.5	82.3	12.1	131.4	0.5	28.1	188.1	68.7	256.8
1979	2.0	*	2.0	21.8	9.6	14.2	1.8	5.3	2.6	0.6	43.1	13.4	90.6	0.7	28.8	143.9	69.5	213.4
1980	**2.3**	*	**2.4**	**29.6**	**8.2**	**11.0**	**2.0**	**4.8**	**2.3**	**0.5**	**16.7**	**13.7**	**59.1**	**0.7**	**29.0**	**120.7**	**70.4**	**191.1**
1981	1.5	0.1	1.6	31.0	8.7	13.5	1.4	6.2	2.2	0.4	29.7	17.8	79.8	0.7	30.6	143.6	72.8	216.4
1982	2.3	0.1	2.4	19.8	7.8	12.2	1.3	4.6	2.0	0.5	34.7	14.2	77.4	0.7	29.5	129.8	70.9	200.7
1983	2.8	*	2.8	36.0	7.5	7.8	0.2	4.0	2.1	0.2	33.6	14.0	69.5	0.7	30.9	139.8	73.8	213.7
1984	2.7	*	2.7	38.5	7.3	8.0	0.1	1.7	2.2	0.6	32.6	16.0	68.6	0.6	33.4	143.8	77.9	221.6

[1] Includes supplemental gaseous fuels.
[2] Liquefied petroleum gases (LPG) series estimates since 1979 may be affected by the changing data sources and estimation procedures. See the LPG notes in the documentation.
[3] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.
* Btu value less than 0.05, and physical unit value less than 0.5.
Note: Totals may not equal sum of components due to independent rounding.
Note: Does not include wood-derived fuel consumed by the industrial sector. Also excludes small quantities of other energy sources for which consistent historical data are not available such as: (1) solar energy obtained by the use of thermal and photovoltaic collectors; (2) wind energy; and (3) geothermal, biomass, and waste energy.
Sources: Data sources, estimation procedures, and assumptions are described in the documentation section of this report.

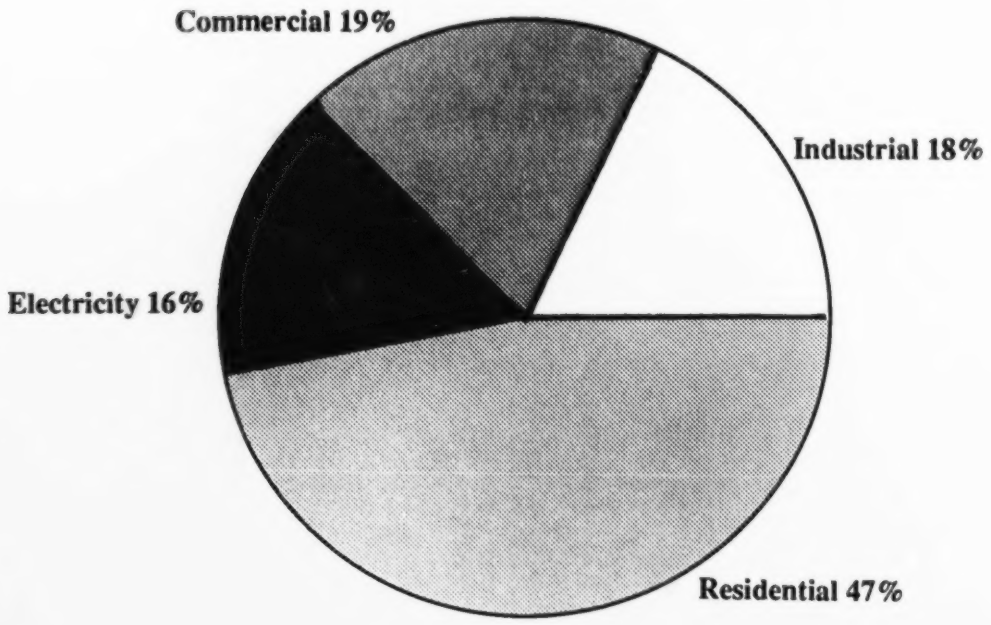
Transportation Energy Consumption Estimates, 1960-1984, Massachusetts

Year	Bituminous Coal and Lignite[1]	Natural Gas[2]	Petroleum: Aviation Gasoline	Distillate Fuel	Jet Fuel	LPG[3]	Lubricants	Motor Gasoline	Residual Fuel	Total	Electrical: Electricity Sales	Electrical System Energy Losses[4]
	Thousand Short Tons	Billion Cubic Feet	Thousand Barrels								Million Kilowatthours	
1960	**22**	*	**942**	**2371**	**1158**	**4**	**443**	**34725**	**1207**	**40850**	**0**	**0**
1961	5	*	821	2311	1501	4	431	35891	2126	43085	0	0
1962	4	*	1404	2150	2011	4	423	36866	2043	44901	0	0
1963	3	*	1563	2706	2350	6	423	37769	1878	46695	0	0
1964	2	*	1731	2730	2357	8	444	38163	1818	47249	0	0
1965	**3**	*	**1578**	**2632**	**3118**	**16**	**408**	**39454**	**2472**	**49679**	**0**	**0**
1966	1	*	1143	2652	3680	8	424	40986	1421	50314	0	0
1967	1	2	580	2606	5366	8	392	42105	2384	53440	0	0
1968	1	2	295	3451	6502	10	431	44709	2226	57625	0	0
1969	1	1	264	3472	7426	10	433	46278	1968	59851	0	0
1970	**0**	**1**	**250**	**3198**	**7819**	**17**	**441**	**49315**	**3215**	**64256**	**0**	**0**
1971	0	1	237	3393	8595	21	452	50632	3475	66806	0	0
1972	0	1	272	4124	8744	27	484	53427	3024	70102	0	0
1973	0	1	252	4529	8904	32	477	55343	2766	72302	0	0
1974	0	1	258	4403	8112	34	456	54058	1446	68768	0	0
1975	**0**	**1**	**206**	**4485**	**7929**	**29**	**433**	**54440**	**1049**	**68572**	**0**	**0**
1976	0	1	220	4437	8005	29	481	56128	1389	70689	0	0
1977	0	*	271	4057	8756	31	463	56731	1282	71591	0	0
1978	0	1	362	4474	8454	30	497	57261	832	71909	0	0
1979	0	1	269	5142	8712	24	520	55233	1531	71432	0	0
1980	**0**	**1**	**274**	**4900**	**8563**	**27**	**463**	**51161**	**900**	**66288**	**195**	**475**
1981	0	1	209	4970	7821	39	444	51798	1062	66344	156	371
1982	0	2	166	5803	7491	44	405	51647	1459	67015	133	318
1983	0	1	148	6706	7840	57	424	52687	152	68014	142	340
1984	0	1	138	7540	8930	93	453	53603	145	70901	149	347

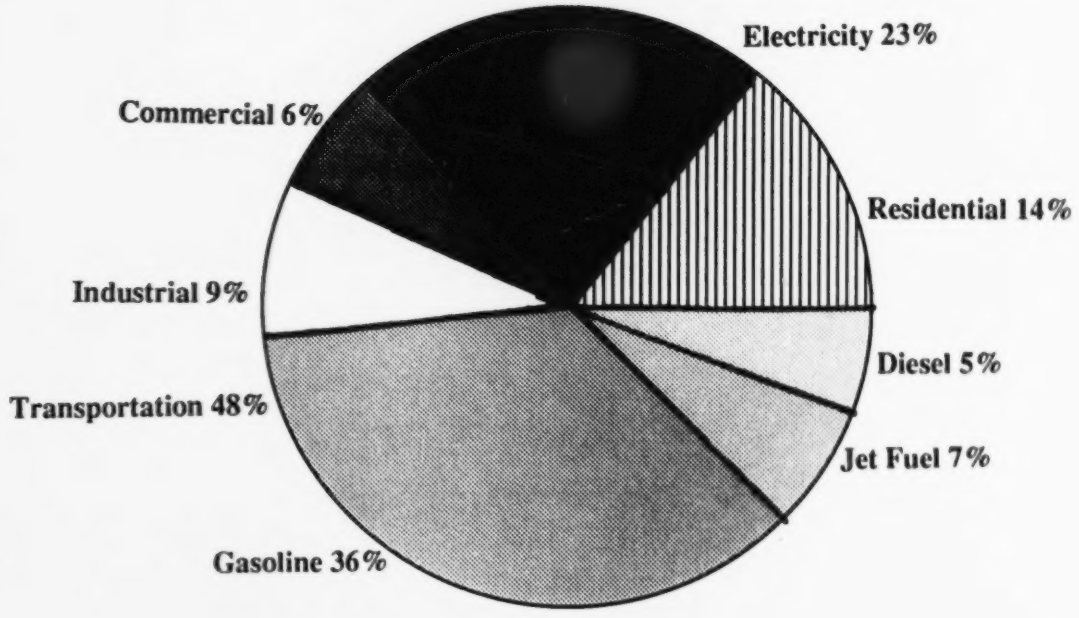
Year	Bituminous Coal and Lignite[1]	Natural Gas[2]	Petroleum: Aviation Gasoline	Distillate Fuel	Jet Fuel	LPG[3]	Lubricants	Motor Gasoline	Residual Fuel	Total	Electrical: Electricity Sales	Subtotal	Electrical System Energy Losses[4]	Total
	Trillion Btu													
1960	**0.6**	**0.3**	**4.8**	**13.8**	**6.5**	*	**2.7**	**182.4**	**7.6**	**217.7**	*	**218.6**	*	**218.6**
1961	0.1	0.3	4.1	13.5	8.4	*	2.6	188.5	13.4	230.5	*	231.0	*	231.0
1962	0.1	0.2	7.1	12.5	11.3	*	2.6	193.7	12.8	240.0	*	240.3	*	240.3
1963	0.1	0.2	7.9	15.8	13.2	*	2.6	198.4	11.8	249.7	*	250.0	*	250.0
1964	0.1	0.2	8.7	15.9	13.2	*	2.7	200.5	11.4	252.5	*	252.8	*	252.8
1965	*	**0.2**	**8.0**	**15.3**	**17.6**	**0.1**	**2.5**	**207.3**	**15.5**	**266.2**	*	**266.5**	*	**266.5**
1966	*	0.4	5.8	15.4	20.8	*	2.6	215.3	8.9	268.8	*	269.2	*	269.2
1967	*	2.0	2.9	15.2	30.3	*	2.4	221.2	15.0	287.0	*	289.1	*	289.1
1968	*	1.7	1.5	20.1	36.7	*	2.6	234.9	14.0	309.8	*	311.6	*	311.6
1969	*	1.0	1.3	20.2	42.0	*	2.6	243.1	12.4	321.7	*	322.7	*	322.7
1970	*	**1.1**	**1.3**	**18.6**	**44.2**	**0.1**	**2.7**	**259.1**	**20.2**	**346.1**	*	**347.3**	*	**347.3**
1971	*	0.7	1.2	19.8	48.6	0.1	2.7	266.0	21.8	360.2	*	360.9	*	360.9
1972	*	0.7	1.4	24.0	49.5	0.1	2.9	280.7	19.0	377.6	*	378.3	*	378.3
1973	*	0.6	1.3	26.4	50.4	0.1	2.9	290.7	17.4	389.2	*	389.8	*	389.8
1974	*	0.7	1.3	25.6	45.9	0.1	2.8	284.0	9.1	368.8	*	369.5	*	369.5
1975	*	**0.5**	**1.0**	**26.1**	**44.9**	**0.1**	**2.6**	**286.0**	**6.6**	**367.3**	*	**367.9**	*	**367.9**
1976	*	0.6	1.1	25.8	45.3	0.1	2.9	294.8	8.7	378.9	*	379.5	*	379.5
1977	*	0.5	1.4	23.6	49.6	0.1	2.8	298.0	8.1	383.5	*	384.0	*	384.0
1978	0.0	0.5	1.8	26.1	47.8	0.1	3.0	300.8	5.2	384.9	*	385.4	*	385.4
1979	0.0	0.7	1.4	30.0	49.3	0.1	3.2	290.1	9.6	383.6	*	384.3	*	384.3
1980	**0.0**	**0.7**	**1.4**	**28.5**	**48.4**	**0.1**	**2.8**	**268.7**	**5.7**	**355.7**	**0.7**	**357.0**	**1.6**	**358.7**
1981	0.0	0.7	1.1	29.0	44.3	0.1	2.7	272.1	6.7	355.9	0.5	357.1	1.3	358.4
1982	0.0	1.6	0.8	33.8	42.4	0.2	2.5	271.3	9.2	360.1	0.5	362.2	1.1	363.3
1983	0.0	1.1	0.7	39.1	44.4	0.2	2.6	276.8	1.0	364.7	0.5	366.2	1.2	367.4
1984	0.0	1.2	0.7	43.9	50.5	0.3	2.7	281.6	0.9	380.7	0.5	382.4	1.2	383.6

[1] No anthracite is consumed by the transportation sector.
[2] Includes supplemental gaseous fuels.
[3] Liquefied petroleum gases (LPG) series estimates since 1979 may be affected by the changing data sources and estimation procedures. See the LPG notes in the documentation.
[4] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.
* Btu value less than 0.05, and physical unit value less than 0.5.
Note: Totals may not equal sum of components due to independent rounding.
Note: Excludes small quantities of other energy sources for which consistent historical data are not available such as: (1) solar energy obtained by the use of thermal and photovoltaic collectors, (2) wind energy, and (3) geothermal, biomass, and waste energy.
Sources: Data sources, estimation procedures, and assumptions are described in the documentation section of this report.

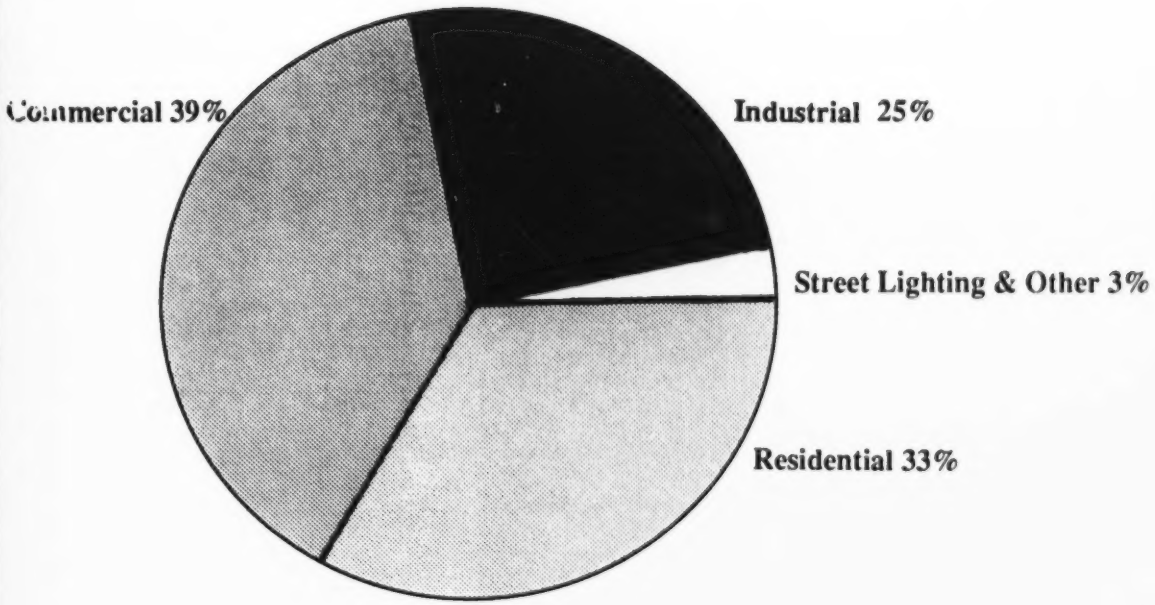
Natural Gas Consumption by Sector, MA 1984



Petroleum Consumption by Sector, MA 1984



Electricity Consumption by Sector, MA 1984



MAJOR ELECTRICITY GENERATING PLANTS IN NEW ENGLAND

Plant Name	Location	Capacity (Megawatts)	Primary (Secondary) Fuel	Units	Company
Massachusetts					
Brayton Point	Somerset	1600	coal (oil)	4	NEES
Northfield Mtn.	Irving	846	pumped hydro	4	NU
Salem Harbor	Salem	805	coal/oil	4	NEES
New Boston	S. Boston	717	oil	2	BECO
Pilgrim	Plymouth	687	nuclear	1	BECO
Mystic 7	Everett	617	oil (gas)	1	BECO
Bear Swamp	Rowe	600	pumped hydro	2	NEES
Canal 1	Sandwich	542	oil	1	CES
Canal 2	Sandwich	529	oil	1	CES
Mystic 4-6	Everett	468	oil	3	BECO
Stony Brook	Ludlow	340	oil (gas)	1	MMWEC
W. Springfield	W. Springfield	209	oil (gas)	3	NU
Somerset	Somerset	194	oil	2	EUA
Yankee	Rowe	158	nuclear	1	Yankee
Mount Tom	Holyoke	136	coal	1	NU
West Medway	West Medway	135	oil (gas)	1	BECO
B. F. Cleary	Taunton	118	oil	2	Taunton, city of
Potter	Braintree	103	oil	2	Braintree, city
Kendall	Cambridge	67	oil (gas)	3	CES
Cannon St.	New Bedford	59	oil (gas)	2	CES
Silver Lake	Pittsfield	54	oil	4	NU
Maine					
Maine Yankee	Wiscasset	864	nuclear	1	Maine Yankee
Wyman 1 - 4	Yarmouth	846	oil	4	CMP
Mason	Wiscasset	146	coal / oil	5	CMP
New Hampshire					
Merrimack	Bow	459	coal (oil)	2	PSCNH
Newington	Newington	414	oil	1	PSCNH
Schiller	Portsmouth	178	coal (oil)	4	PSCNH
Comerford	Monroe	140	hydro	4	NEES
S.C. Moore	Littleton	140	hydro	4	NEES

Vermont

Vermont Yankee	Vernon	563	nuclear	1	Vermont Yankee

Connecticut

Millstone	Waterford	2671	nuclear	3	NU
Middletown	Middletown	837	oil (coal)	4	NU
Bridgeport Harbor	Bridgeport	660	oil (coal/ refuse	3	UI
Conn. Yankee	Haddam	600	nuclear	1	Conn. Yankee
Montville	Montville	489	oil	2	NU
New Haven	New Haven	464	oil	1	UI
Devon	Milford	429	oil / coal	6	NU
Norwalk Harbor	Norwalk	326	oil /coal	2	NU
South Meadow	Hartford	167	oil	4	NU

Rhode Island

Manchester St.	Providence	132	oil (gas)	3	NEES
South St.	Providence	110	coal (oil)	3	NEES

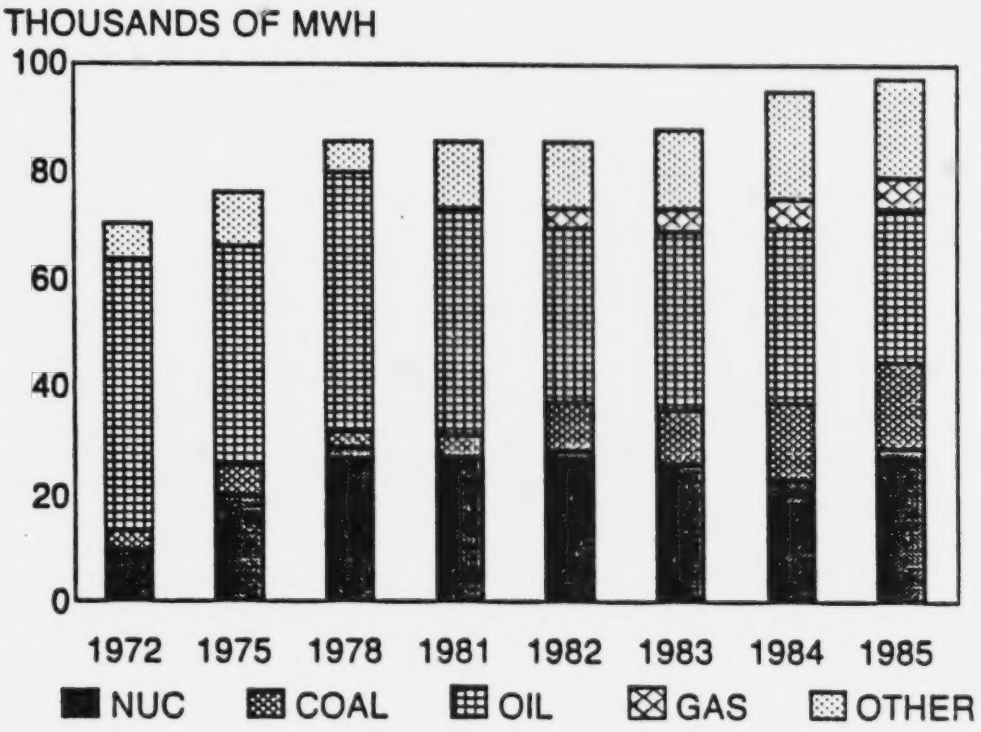
Key to abbreviations

NEES: New England Electric System (Massachusetts Electric, Granite State Electric, Narragansett Electric)
NU: Northeast Utilities (Western Massachuestts Electric and Connecticut Light and Power Company)
BECO: Boston Edison Company
CES: Commonwealth Energy System (Cambridge Electric Light, Commonwealth Electric, and Canal Electric)
MMWEC: Massachusetts Municipal Wholesale Electric Company
EUA: Eastern Utilities Associaties (Eastern Edison and Blackstone Valley Electric)
CMP: Central Maine Power Company
PSCNH: Public Service Corporation of New Hampshire
UI: United Illuminating Company
Yankee: Jointly-owned nuclear generating company

Supply and distribution of electricity in New England is coordinated by NEPOOL, the New England Power Pool to which all of the above utilties belong.

NEPOOL

Fuel Mix 1972 – 1985

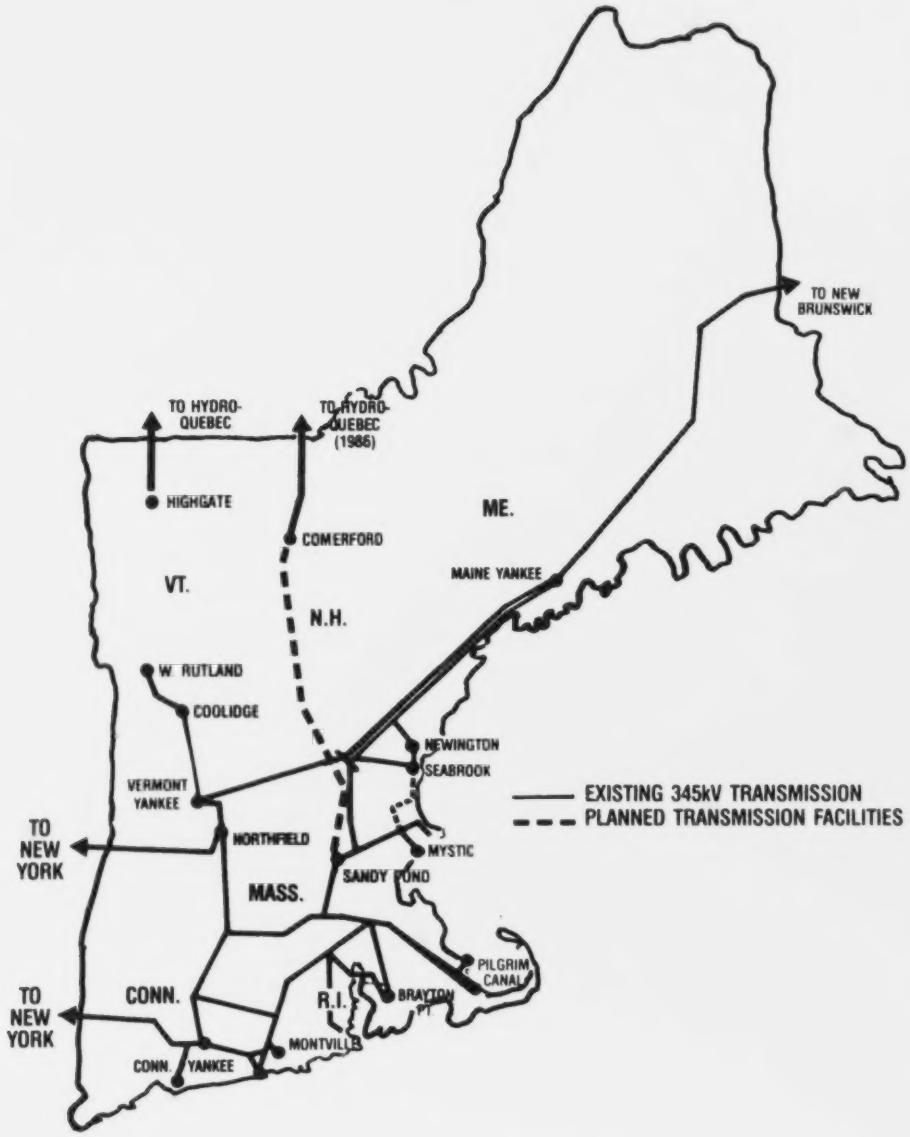


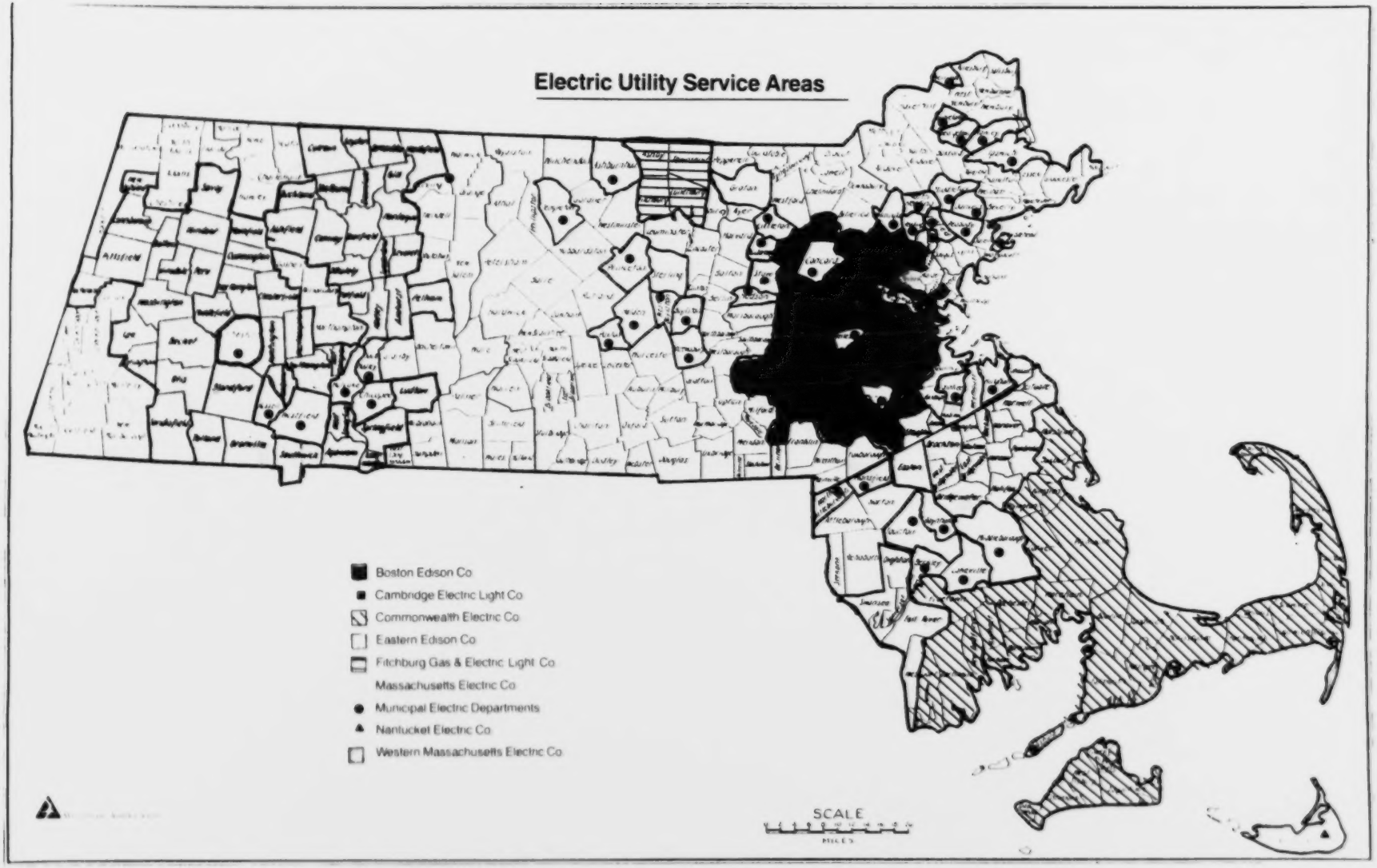
Year	Coal kWhs	Coal % of Total	Oil* kWhs	Oil* % of Total	Gas kWhs	Gas % of Total	Nuclear kWhs	Nuclear % of Total	Hydro kWhs	Hydro % of Total	Total Net Generation kWhs	Total Net Generation % of Total	Net Imports kWhs	Net Imports % of Total	Total kWhs
1974	5,147	7.1%	41,559	57.4%	862	1.2%	16,911	23.3%	4,754	6.6%	69,233	95.6%	3,211	4.4%	72,444
1975	4,378	6.0	40,765	55.8	192	0.3	19,978	27.3	4,619	6.3	69,932	95.7	3,113	4.3	73,045
1976	1,972	2.5	43,199	55.7	271	0.4	25,184	32.5	5,232	6.8	75,858	97.9	1,634	2.1	77,492
1977	2,614	3.3	42,920	53.8	321	0.4	25,530	32.0	4,892	6.2	76,277	95.7	3,464	4.3	79,741
1978	1,967	2.4	45,444	55.4	125	0.2	28,028	34.2	4,176	5.1	79,740	97.3	2,237	2.7	81,977
1979	2,890	3.4	43,390	51.9	734	0.9	26,729	32.0	4,513	5.4	78,256	93.6	5,347	6.4	83,603
1980	4,539	5.4	47,234	55.8	576	0.7	22,450	26.5	3,404	4.0	78,203	92.4	6,447	7.6	84,650
1981	4,467	5.3	41,224	49.0	796	1.0	25,785	30.7	4,640	5.5	76,912	91.5	7,158	8.5	84,070
1982	11,199	13.3	33,440	39.8	1,471	1.8	26,497	31.6	4,398	5.2	77,005	91.7	6,928	8.3	83,933
1983	11,927	13.6	32,716	37.1	2,584	2.9	26,251	29.8	4,687	5.3	78,165	88.7	9,981	11.3	88,146
1984	14,623	15.9	34,146	37.0	3,576	3.9	23,786	25.8	4,600	5.0	80,731	87.6	11,456	12.4	92,187

*Includes insignificant amounts of generation from wood and waste

Source: Generation — U.S. Energy Information Administration
Net Imports — New England Power Pool

MAJOR NEPOOL INTERCONNECTIONS



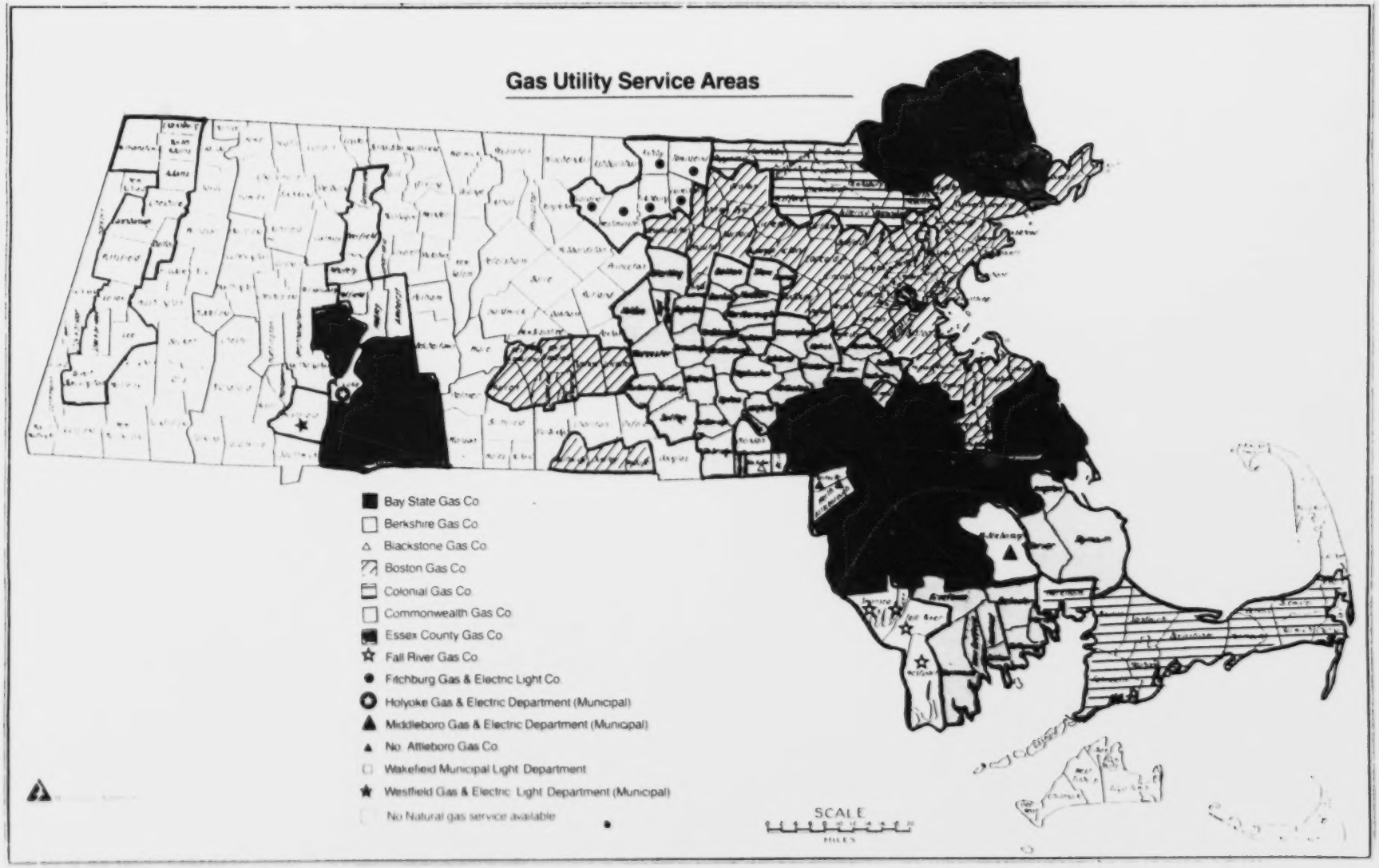

Electric Utility Service Areas
Boston Edison Co
Cambridge Electric Light Co
Commonwealth Electric Co
Eastern Edison Co
Fitchburg Gas & Electric Light Co
Massachusetts Electric Co
Municipal Electric Departments
Nantucket Electric Co
Western Massachusetts Electric Co
SCALE
MILES

Energy Sales to Ultimate Customers

Millions of Kilowatthours
Total Electric Utility Industry

	Year	Total	Residential	Commercial	Industrial	Street Lighting	Other
Maine	1974	6,236	2,409	1,267	2,334	60	166
	1975	6,342	2,524	1,336	2,255	63	164
	1976	6,892	2,803	1,500	2,377	66	146
	1977	7,307	2,886	1,580	2,630	68	143
	1978	7,699	3,014	1,633	2,841	68	143
	1979	7,905	3,065	1,551	3,073	69	147
	1980	7,975	3,053	1,556	3,162	63	141
	1981	8,137	3,065	1,587	3,267	65	153
	1982	8,204	3,034	1,584	3,396	65	125
	1983r	9,017	3,185	1,954	3,686	63	129
	1984p	9,617	3,370	2,076	3,975	64	132
New Hampshire	1974	4,904	2,156	779	1,902	36	31
	1975	4,895	2,171	810	1,838	39	37
	1976	5,314	2,345	861	2,029	39	40
	1977	5,469	2,371	913	2,103	41	41
	1978	5,832	2,456	970	2,323	42	41
	1979	6,056	2,507	1,017	2,444	42	46
	1980	6,072	2,525	1,047	2,424	27	49
	1981	6,093	2,505	1,076	2,421	45	46
	1982	6,144	2,554	1,135	2,371	45	39
	1983r	6,384	2,605	1,227	2,462	44	46
	1984p	6,787	2,764	1,397	2,536	44	46
Vermont	1974	3,054	1,478	532	900	18	126
	1975	3,036	1,461	553	882	18	122
	1976	3,254	1,553	597	960	19	125
	1977	3,366	1,568	622	1,018	19	139
	1978	3,524	1,597	639	1,123	19	146
	1979	3,587	1,618	650	1,163	19	137
	1980	3,750	1,672	677	1,245	16	140
	1981	3,889	1,734	688	1,324	20	123
	1982	3,938	1,762	716	1,328	19	113
	1983r	3,993	1,730	750	1,381	19	113
	1984p	4,228	1,853	797	1,443	19	116
Massachusetts	1974	29,259	10,902	9,422	8,099	315	521
	1975	29,601	10,988	10,171	7,555	311	576
	1976	31,271	11,715	10,842	7,802	392	520
	1977	31,551	11,595	10,886	8,180	425	465
	1978	32,354	11,756	11,202	8,464	436	496
	1979	33,099	11,922	11,436	8,803	452	486
	1980	33,252	11,973	11,562	8,745	424	548
	1981	33,223	11,810	11,731	8,714	420	548
	1982	33,263	11,983	12,102	8,206	401	571
	1983r	35,055	12,461	12,880	8,760	393	561
	1984p	37,276	13,009	13,853	9,487	390	537
Rhode Island	1974	4,551	1,642	1,359	1,421	60	69
	1975	4,417	1,689	1,377	1,218	63	70
	1976	4,824	1,826	1,497	1,341	64	96
	1977	4,828	1,782	1,524	1,352	70	100
	1978	4,974	1,822	1,603	1,379	71	99
	1979	5,059	1,832	1,657	1,399	72	99
	1980	5,088	1,840	1,675	1,406	67	100
	1981	5,028	1,807	1,675	1,367	75	104
	1982	4,938	1,826	1,692	1,240	73	107
	1983r	5,174	1,914	1,768	1,309	72	111
	1984p	5,373	1,956	1,851	1,382	72	112
Connecticut	1974	18,819	7,472	5,476	5,627	217	27
	1975	18,603	7,475	5,738	5,143	219	28
	1976	19,618	7,874	6,041	5,448	224	31
	1977	20,229	8,020	6,297	5,648	231	33
	1978	20,906	8,168	6,495	5,975	233	35
	1979	21,377	8,220	6,649	6,241	230	37
	1980	21,444	8,265	6,789	6,114	232	44
	1981	21,516	8,188	6,939	6,121	225	43
	1982	21,194	8,105	7,132	5,692	224	41
	1983r	22,092	8,358	7,529	5,915	217	73
	1984p	23,087	8,571	7,948	6,227	215	126

r - revised
p - preliminary
Separation of energy sales into classifications may not be consistent from year to year due to changes in accounting practices.


Gas Utility Service Areas
Bay State Gas Co.
Berkshire Gas Co.
Blackstone Gas Co.
Boston Gas Co.
Colonial Gas Co.
Commonwealth Gas Co.
Essex County Gas Co.
Fall River Gas Co.
Fitchburg Gas & Electric Light Co.
Holyoke Gas & Electric Department (Municipal)
Middleboro Gas & Electric Department (Municipal)
No. Attleboro Gas Co.
Wakefield Municipal Light Department
Westfield Gas & Electric Light Department (Municipal)
No Natural gas service available
SCALE
MILES

WEATHER DATA FOR SELECTED NEW ENGLAND CITIES AND TOWNS

Degree days by month [a]

City	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
Boston,	0	7	77	315	618	998	1113	1002	849	534	236	42	5791
Nantucket,	22	34	111	372	615	924	1020	949	880	642	394	139	6102
Worcester	6	34	147	450	774	1172	1271	1123	998	612	304	78	6969
Pittsfield,	25	59	219	524	831	1231	1339	1196	1063	660	326	105	7578
Albany, NY	0	19	138	440	777	1194	1311	1156	992	564	239	45	6875
Hartford, CT	0	14	101	384	699	1082	1178	1050	871	528	201	31	6139

[a] Degree days are calculated by subtracting the average temperature from 65°. For example, the average temperature for a day is 40°; for this example, this day would be a 25 degree day. Monthly totals are obtained by adding totals for each day. Above chart is averaged over a thirty year period.

AVERAGE PERCENTAGE SUNSHINE FOR SELECTED NEW ENGLAND CITIES

City	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Annual
Boston	64	63	61	58	48	48	47	56	57	56	59	62	57
Hartford	62	60	57	55	46	46	46	55	56	54	57	60	56
Albany	63	61	58	54	39	38	43	51	53	53	57	62	53

RESIDENTIAL WOOD CONSUMPTION IN NEW ENGLAND

State	% of households using wood for heating 1978-1979 [a]	Cords burned 1978-1979	% of households using wood for heating 1982 [b]	Cords burned 1982
CT	14%	668,000	17%	660,000
ME	28%	575,000	50%	1,193,000
MA	9%	815,000	19%	1,201,000
NH	26%	394,000	47%	545,000
RI	6%	108,000	6% [c]	225,000
VT	27%	313,000	48%	500,000

According to the report from which these numbers are obtained, "in 1982 wood provided approximately 14% of New England's total net residential energy requirements."

Sources: New England Wood and Energy reports, 1982-83, Department of Agriculture, Economic Research Service. Estimates for 1982 based upon information provided by the six New England state energy offices.

Notes:

[a] Percentage of households using wood for primary or secondary heating do not include wood in rental housing, second homes or in fireplaces or fireplace inserts.

[b] Percentage of household using wood for primary or secondary heating generally do not include use of fireplaces and second homes.

[c] Rhode Island's percentage is probably considerably higher. The state has not conducted a subsequent survey to determine how many households are currently using wood for primary or secondary heating needs.

Figures and Notes excerpted from a report by the New England Congressional Instititute. More recent data are not available.

QUESTIONS ABOUT UNITED STATES ENERGY DATA

1. Which states consume the most energy?

2. In what five states is the average consumption of energy per person the greatest? What are some possible explanations for this rate? Support your theory with data from the tables.

3. In which state is the largest industrial usage of energy found?

4. In which state is the largest transportation usage of energy found?

5. Which state consumes the most coal? petroleum? and natural gas?

6. Massachusetts, Indiana, and North Carolina had approximately equal populations in 1980 yet the per capita energy use in much smaller in Massachusetts. What factors might acount for these differences?

7. Which state exhibited the greatest percentage growth in energy consumption between 1973 and 1984? In which state did energy use drop by the greatest percentage?

Questions for discussion and further investigation

1. Are the states that consume the most coal, natural gas, or petroleum the same states that produce the greatest amount of the resource?

2. Why is the industrial energy consumption so high in Texas and Louisiana?

QUESTIONS ABOUT MASSACHUSETTS ENERGY DATA

1. In which year did Massachusetts use the most energy?

2. What are the three largest uses of petroleum in Massachusetts?

3. How has the generation of electricity in Massachusetts changed since 1970?

4. How does the amount of energy consumed per person in Massachusetts compare to that in other states?

5. Including electricity consumed, which end-use sector -- residential, commercial, industrial, transporation --used the most energy in Massachusetts?

6. Which fuel supplies the greatest percentage of energy in Massachusettts?

7. Since 1970, what is the energy source that has experienced the greatest percentage growth in the residential sector?

8. Energy use in Massachusetts has fallen greatly since 1973, largely because of a decline in the use of petroleum. Which sector -- residential, commercial, industrial, or transportation -- has reduced its consumption by the greatest number of barrels?

Questions for further investigation

1. What might be some reasons for the yearly changes in the amount of energy supplied by hydro power?

2. Compare the amount of non-electrical energy used in the residential sector with the amount of electrical energy used.

3. From what states does Massachusetts obtain its natural gas ?

4. Which group of industries uses the most energy? Which the least? Which industry in your town uses the most energy? (A good starting point for this information is the Annual Survey of Manufacturers -- Fuels and Electric Energy Consumed, by the U.S. Census.)

5. The data on residential wood heat is from 1982 and before. Do you think the information is still accurate? Design a survey of your town to see if this information was representative of your town for the years of the data and what is the extent of wood heating presently.

6. How many miles per year does the average driver in Massachusetts drive? Has this number increased, decreased, or remained constant in the years since 1970?